NEW ENGLAND WATER WORKS ASSOCIATION.

ORGANIZED 1882.

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This Association, as a Body, is not responsible for statements or opinions of any of its members.

PROCEEDINGS OF THE EIGHTH ANNUAL CONVENTION.

FALL RIVER, MASS., June 12, 13, 14, 1889.

WEDNESDAY, June 12, 1889.

AFTERNOON SESSION.

The Convention was called to order at 3 o'clock, P.M., by President Nevons. Prayer was offered by the Rev. W. W. Adams. Alderman Charles J. Holmes, representing the Mayor, then addressed the Convention, as follows: —

ADDRESS OF WELCOME BY ALDERMAN HOLMES.

Mr. President and Gentlemen of the New England Water Works Association, — In the absence of the chief executive it falls upon me to welcome you to our city. I am obliged to be brief in my remarks on account of other engagements, but you will excuse me, especially as I understand you yourselves propose to do most of the talking during your sessions here. I will only say that your fame has preceded you, and we expect a good deal from you. One of the greatest problems for our municipalities is perhaps that of getting good water, taking care of it while we have it, and disposing of it when we are through with it. This is a subject to which you have all especially addressed yourselves, and it is one in which we are all interested; and I hope that the Convention which you are to hold here will be profitable to us as well as to you, and that your stay here will be agreeable. I will now leave your President to direct the business of your Convention as he may see fit. [Applause.]

RESPONSE BY PRESIDENT NEVONS.

Allow me, sir, in behalf of the New England Water Works Association, to thank you, and through you the members of your city government, for your cordial welcome to us. We are a body of practical men, met together seeking information, by social intercourse and exchange of thought, on subjects of great importance in relation to questions which arise in every city and town that has a water-supply or is looking for one. We have come to your city from widely separated homes and fields of labor. When our membership roll is called the

answer comes from the Provinces, the rocky shores of Maine, the granite hills of New Hampshire and Vermont, from on through the New England States to the golden West, down through the sunny South; and across the water from the land of the thistle and the heather, from Scotland's famous old city of Glasgow, we are still honored with the answer, "Here." And, sir, we expect our membership to be as widely extended as the Yankee jack-tar said that Uncle Sam's dominions were, after listening to the English tar's boast of the Queen's dominions, and that the true bounds of our membership will be "the aurora borealis and the south pole." [Laughter and applause.]

Again thanking you for the courteous words you have spoken, I will add, we extend to the members of your city government a hearty invitation to be present at our deliberations while we are in your city, and express the hope that none of the good people of Fall River will ever regret that the New England Water Works Association held its Eighth Annual Convention here.

On motion of the Secretary, the reading of the minutes of the last meeting was dispensed with, they having already appeared in print.

ELECTION OF MEMBERS.

The Secretary presented the following names of applicants, all of whom had been considered and approved by the Executive Committee: —

FOR RESIDENT ACTIVE MEMBERSHIP.

J. White Belcher, Water Commissioner, Randolph, Mass.
L. M. Hastings, City Engineer, Cambridge, Mass.
Wm. F. Harbach, Water Commissioner, Newton Centre, Mass.
Augustus W. Locke, Civil Engineer, North Adams, Mass.
E. T. Wiswall, Water Commissioner, West Newton, Mass.
Horace H. Lowe, Superintendent, Clinton, Mass.
John F. Plunkett, Registrar, Marlborough, Mass.

FOR NON-RESIDENT ACTIVE MEMBERSHIP.

Carroll Ph. Bassett, Civil Engineer, Newark, N. J.
C. Emmett Bennett, Superintendent, Ticonderoga, N. Y.
H. M. Fales, Superintendent, Tonawanda, N. Y.
H. W. Greetham, Local Manager, Orlando, Fla.
E. H. Keating, City Engineer, Halifax, Canada.
W. H. Laing, Superintendent, Racine, Wis.
Robert K. Martin, Chief Engineer, Baltimore, Md.
G. A. Roullier, Superintendent, Flushing, N. Y.

FOR ASSOCIATE MEMBERSHIP.

Walter B. Nye, "Warren Filter," Boston, Mass.
Samuel L. Monson, "United Brass Co.," New York City.
Galvin Brass and Iron Co., "Valves, Hydrants, etc.," Detroit, Mich.
Nathl. C. Locke, "Damper Regulator," Salem, Mass.
A. W. Worthley, "American Frost Meter Co.," Boston, Mass.

On motion of Mr. Glover, the Secretary was requested to cast the ballot of the Association in favor of the admission of all the applicants, and he having done so, they were declared elected.

ADDRESS OF THE PRESIDENT.

President Nevons then addressed the Association as follows: —

Gentlemen of the New England Water Works Association, — We have met to-day, for the eighth time, in Annual Convention.

We have held five meetings since our last annual meeting in Providence. The first of these was a field day at Cambridge, in September. The weather was discouraging in the morning, but it cleared away toward noon. As about one hundred members had arrived, the full programme was carried out, and a very enjoyable day was spent in visiting the water works, the Stony-brook dam, and other places of interest.

The other four meetings were held at Young's Hotel, in Boston, in December, January, February, and March. The average attendance at these was about seventy-eight, showing an increasing interest of the members and friends of our Society. There has been no lack of subjects, or of those ready to discuss them. The special papers which have been read have received favorable notice from those by whom we naturally desire to be recognized. They have tended to increase our reputation as a live Association, and one whose influence is being felt in the important department we represent. The more informal discussion of these papers, and the meetings mainly given up to short addresses on a great variety of topics connected with water works, have also been solid, and exceedingly helpful.

The Association is to be congratulated on its acquisition of many valuable new members during the year past, and on the prosperous state of its treasury, of which our Secretary and our Treasurer will speak in detail.

Your President has ventured to make a new departure in two respects. We are taught and recognize the fact that no one should ever enter upon any great or important undertaking without first invoking a blessing from Deity; and also that the harmony of music begets harmony of feeling among men in all stations of life. One of the changes made by your President during the past year has accordingly been the introduction of music into our meetings, in order to give variety and add spice to the exercises. He was delighted to have the Association approve of this, and adopt it as a stated feature of our gatherings. The other change has been the offering of grace at our banquets, or of a brief prayer at our more formal meetings. Surely our deliberations are of enough importance to the public health and the public welfare for us to ask God's blessing on them, and our pleasure at our gatherings deserves the return of thanks to the great Giver who sendeth rain from heaven, and fruitful fields, filling our hearts with joy and gladness. May I be allowed to express the hope that this precedent, also, will be followed in the time to come.

Now, lest what I have said should seem like glorying, let me say that the past year has been a disappointment to me. I anticipated a great deal of labor and discomfort in the performance of my duties. But thanks to your courtesy and

generosity in overlooking what was lacking in me, and to your responsiveness and hearty coöperation, and thanks especially to the associated officers, the Executive Committee, and those who have responded so willingly to calls made on them for service, I have had my duties much lightened, and have found great pleasure in the service. In short, the progress which has been made has been largely due to you, while the honor which you have conferred on me is one which I shall long remember.

I should do injustice to my own feelings if I failed to return special thanks to our faithful and untiring Secretary for his uniform kindness and courtesy in cheerfully meeting all of the perplexing duties connected with his office. I dare say the question has occurred to you, as it has to me, whether, in view of the growth of the Association, and of its manifold and important relations, the time has not arrived for us to employ a Secretary to give his entire time to the Association's work; and, if so, whether we can find a man so well qualified for precisely this position as our present Secretary. It gives me pleasure to add to my thanks to him, the more general but equally true statement, that there has been the best of harmony in our intercourse as officers and members.

But let us take a longer retrospect. Let us look back, not over the pleasant year just closing, but over the eight years since the New England Water Works Association was organized. Eight years are a long time for men to be in school or at college. Are we better men in the places we occupy, and in the communities in which we live? Have we learned all there is to be learned in our calling, or have we exhausted the subjects relating to it so that there is nothing left for us to learn? I think, on the contrary, that our experience in our work, and our opportunities in this Association, have only opened wider fields of inquiry, and extended, to our conception, the bounds of that which we desire to master.

But he who is desirous of obtaining information should be ready in return to impart of his experience and thought, thus broadening knowledge by a mutual exchange of it. The advancement made has been great, far beyond the anticipations of the few who assembled at Young's Hotel eight years ago and organized this Association. We were isolated at that time. But few of our number had been educated for this peculiar vocation. We were meeting troubles and perplexing questions, and were so absorbed in them that we thought we were the only ones who had difficulties. And with theory for a starting-point we were in the way of learning well, at least; but when we backed it up with practice, and came out about right, perhaps some of us even thought we knew it all. But the eight years of social intercourse and personal interchange of thought and experience (the unwritten work of our meetings, and sometimes I think the best part) have changed all that. I refer to when two or more get together and relate some instance, or express an idea, and it is taken up and discussed, and some one of the number gets a thought, and, working it out, gets from it important results.

The systems and methods of practice on the different water works of New England, and in fact of the United States, are an open book to all who are interested. The subjects which have been brought before the Association and discussed have been those of the greatest importance in their relation to the economy and management of water works; and though mainly technical, they have occasionally branched out, as should sometimes be the case, into broader fields. Let

me refer, for an example, to a paper read during the past year, on "Water in some of its Higher Relations," commenting on which, as printed in our JOURNAL, one of the Boston papers said that it "treats the subject entirely outside of its technical limitations, and in relation to the world and life at large," and adds, "whoever wishes to read one of the freshest literary essays of the season will hunt up this periodical." I instance this to emphasize an element which, as it seems to me, ought occasionally to be introduced into our meetings and into our private studies, in order that we may be broader than merely technical men. I wish that at least once each year we might have an essay, or an oration, or lecture, reaching thus broadly out into the great world of fact and of life, of which our greatest "works" and achievements are only a tiny part. But, to go back to what I was saying, the subjects discussed by the Association are so many and varied that they cannot be referred to at this time. They will be found recorded in the JOURNAL of the Association, which has a wide circulation, and is a very important record.

I think I may say of our Association, that it is recognized as an institution of importance by the best business and professional men. There is not a city or town having water works but has been benefited by it. It is, therefore, well for us to leave our fields of labor on these beautiful June days, and assemble together, and lay broad and comprehensive plans for the future, never losing sight of the fact that we are a body of practical business men, — representatives of one of the most important departments connected with any city or town. Let us be social and have a good time, but let us never forget the dignity due to such a representation. As business men, in commencing a piece of work, we have a starting-point. Let us think out carefully the work before us, that we may avoid mistakes from beginning to end.

In conclusion, let me thank you for your attention, and allow me to urge upon you, one and all, to guard with jealous care the interests of the Association, that it may attain from year to year a higher and yet higher standing and usefulness. [Applause.]

REPORT OF THE SECRETARY.

Secretary Coggeshall then read the following report: —

NEW ENGLAND WATER WORKS ASSOCIATION,
OFFICE OF THE SECRETARY,
NEW BEDFORD, June 3, 1889.

Gentlemen of the New England Water Works Association, — Your Secretary herewith presents his report for the year ending June 1, 1889: —

A year ago the membership of this Association was as follows, viz.: —

Active members	181
Honorary members	3
Associate members	54
Total	238

During the year there has been a loss of nine members from the following stated causes: —

Deceased	3
Resignations received	3
Suspended for non-payment of dues	3

Fifty-one applications for membership have been presented for your consideration, all of which have received favorable action.

Our total membership is now: —

Active members	209
Honorary members	4
Associate members	64
Total	277

The net gain for the year has been 41 members.

Your Secretary has made 324 collections, which may be thus itemized: —

From Advertisements	$1,130 00
Initiation fees	287 00
Dues	674 50
Sale of transactions	59 88
Total	$2,151 38

All of which has been paid to the Treasurer.

Respectfully submitted,

R. C. P. COGGESHALL,

Secretary.

On motion of Mr. Clark, the report was accepted and placed on file.

A GAVEL PRESENTED TO THE ASSOCIATION.

The President called the attention of the Convention to a gavel which had been sent to him by Mr. J. M. Diven, Secretary of the American Water Works Association, and which, in behalf of the donor, he presented to the Association.

On motion of Mr. Brackett it was voted to accept the gift, and the Secretary was directed to convey the thanks of the Association to Mr. Diven.

REPORT OF THE TREASURER.

Mr. Glover then read the report of the Treasurer, which was as follows: —

REPORT OF ALBERT S. GLOVER, TREASURER,

TO THE

NEW ENGLAND WATER WORKS ASSOCIATION.

Gentlemen, — I have the honor to herewith submit a record of my doings as your Treasurer, for the year ending with date: —

1888.		RECEIPTS.	
June 12.	Balance on hand, beginning of year,		$888 31
July 24.	Interest received,		30 19
Oct. 19.	Received from R. C. P. Coggeshall, Secretary,		300 00
1889.			
Jan. 14.	" " " "		400 00
May 22.	" " " "		1,000 00
June 3.	" " " "		451 38
" 3.	" " interest,		22 50
Total receipts,			$3,092 38

1888.		EXPENDITURES.	
June 14.	Paid	R. C. P. Coggeshall, for Association expenses at Providence,	$25 00
July 10.	"	J. P. Bacon, reporting meeting,	59 00
" 30.	"	Edwin Darling, for Association expenses at Providence,	41 00
Aug. 1.	"	American Photo. Co., for cut,	1 50
" 2.	"	C. H. Stacy, postage and telegrams,	10 84
" 27.	"	Albert S. Glover, for sundry payments on account of advertisements,	53 60
" 27.	"	Heliotype Printing Co., for heliotypes,	17 50
Oct. 18.	"	The Day Co., printing JOURNAL, etc.,	176 03
" 18.	"	W. H. Richards, postage, expressage, etc.,	7 41
" 22.	"	Mercury Publishing Co., printing,	59 40
Nov. 17.	"	"Railroad Gazette," cut,	2 05
" 17.	"	H. D. Utley & Co., envelopes, etc.,	6 15
" 17.	"	W. H. Richards, travel, expressage, etc.,	8 57
Dec. 20.	"	Heliotype Printing Co., heliotypes,	22 50
" 20.	"	F. L. Pratt, music furnished December meeting,	15 00
" 20.	"	J. R. Whipple, December meeting at Young's Hotel,	21 50
1889.			
Jan. 15.	"	J. R. Whipple, January meeting at Young's Hotel,	18 70
" 29.	"	The Day Co., printing JOURNAL, etc.,	104 50
" 29.	"	F. L. Pratt, music furnished at January meeting,	15 00
Feb. 3.	"	W. H. Richards, envelopes, clerical assistance, travel,	27 01
" 13.	"	J. R. Whipple, February meeting at Young's Hotel,	26 00
" 13.	"	F. L. Pratt, music at February meeting,	15 00
Mar. 13.	"	J. R. Whipple, March meeting at Young's Hotel,	11 40
" 13.	"	F. L. Pratt, music at March meeting,	15 00
" 30.	"	P. O'Brien & Son, flowers at Mr. Barbour's funeral,	6 00
" 30.	"	American Photo. Co., cut diagram,	7 50
" 30.	"	Walter Rogers & Co., reporting January meeting,	30 75
" 30.	"	Walter Rogers & Co., reporting February and March meetings,	37 50
Carried forward,			$841 41

	Brought forward,		$841 41
May 1.	Paid	W. H. Richards, for postage, expressage, clerical assistance, etc.,	13 98
" 27.	"	R. C. P. Coggeshall, for postage, telegrams, and expressage,	101 16
" 27.	"	R. C. P. Coggeshall, salary as Secretary,	300 00
" 27.	"	Edwin Dews, envelopes, etc.,	11 80
" 27.	"	Albert S. Glover, for services as business manager of Association JOURNAL, as per vote of executive committee,	300 00
" 27.	"	Mercury Publishing Co., for letter-heads, circulars, envelopes, printing, etc.,	89 00
	Total expenditure,		$1,657 35

To this, however, should be added the amount of the following-named bills, all of which were duly contracted and have been duly approved, but which were received by the Treasurer too late for payment before the meeting: —

The Day Co., for printing No. 3 of the JOURNAL, etc.,	$237 80	
" " " " " " 4 " " "	197 55	
The Heliotype Printing Co., heliotypes for No. 4 of JOURNAL,	35 00	
		470 35
Making the actual expenditure for year,		$2,127 70

RECAPITULATION.

Amount received by Treasurer during year,	$3,092 38
" paid " " " "	2,127 70
Leaving balance on hand,	$964 68

Respectfully submitted,

ALBERT S. GLOVER,
Treasurer.

FALL RIVER, MASS., June 12, 1889.

On motion of Mr. Coggeshall the report was received and placed on file. Mr. Glover stated that the Finance Committee, a report from which was the next business in the regular order, had not had a meeting and were therefore not prepared to report.

COMMUNICATIONS.

The Secretary read letters from Chester W. Kinsley, Rev. D. N. Beach, J. Herbert Shedd, and Geo. P. Westcott, regretting their inability to be present during the Convention.

REPORT OF COMMITTEE ON BADGES.

Mr. Darling, chairman of the Committee on Badges, exhibited a sample of a badge, being a button bearing the letters, "N.E.W.W.A.," which the committee recommended for adoption by the Association. Mr. Osborne moved to accept the report and adopt the recommendation. Mr. Brackett suggested it would be well to postpone action until the members had had opportunity to inspect the badge. Mr. Darling said he had no objection, and on a motion of Mr. Brackett the matter was laid on the table.

COMMITTEE TO NOMINATE OFFICERS.

On motion of Mr. Darling, the following committee was appointed by the President to nominate officers for the ensuing year: Messrs. Brackett, of Boston; Hall, of Quincy; Holden, of Nashua, N. H.; Kieran, of Fall River; and Rogers, of Salem.

COMMITTEE ON BLUE PRINTS.

On motion of Mr. Coggeshall (amended by Mr. Richards), the following committee was appointed by the President to attend to the distribution of blue prints: Messrs. Richards, of New London, Conn.; Cook, of Woonsocket, R. I.; Robertson, of Fall River; and Wilder, of Woodstock, Vt.

The next business, in regular order, was the report of the Committee on Pipe Joints and Special Castings. Secretary Coggeshall explained that there had been a misunderstanding as to the appointment of the committee, and on his motion the subject was passed.

Supt. George A. Stacy, of Marlboro', Mass., then read a paper entitled "Hydrants," which was discussed by Messrs. Richards, Brackett, Darling, and Clark.

HOW TO SET HYDRANTS TO PREVENT FREEZING.

The PRESIDENT. — We will now take up, gentlemen, the first on our list of general topics, "Suggestions as to the best method to set hydrants to prevent freezing," and I will first call on Mr. Rogers, of Salem.

Mr. ROGERS. — What I have to say follows in the line of the paper which has been read, and the suggestions which have been made, although I feel as though I can hardly add anything to what we have heard thus far. I have an idea that there is no rule, except a very general rule, that can be given for setting hydrants; and that is, that they should be set below the point of frost. Of course, if that were possible in all cases, that would be the only necessary thing to do to prevent them from freezing, or at least to prevent a large part of the trouble. Of course there are cases where it is difficult to set them so deep, but I think it is better to go to considerable expense to do it than it is to place a hydrant in a position where it is bound to be a nuisance and is pretty sure to call for extra expense in maintaining it. I presume if there is a right understanding between the water department and the city or town authorities having charge of the location of hydrants, if there is a right understanding between the fire department and the water department, it can be satisfactorily arranged to have the position of

a hydrant vary from the specified number of feet, if by so doing a point can be reached at which it will, perhaps, be possible to place it more easily and at less expense. Of course it costs something to take up rock, but it is better to do it and thereby get the hydrant down deep enough, than it is to place the hydrant where it is liable to freeze. I think more thought has been given to this subject within a few years than was formerly given to it. Four feet, four and a half, or even five feet may not be deep enough to be beyond the reach of frost. As the result of my experience, which has been supplemented the last year or two by my observations down in the State of Maine and in New Brunswick, where the frost goes deeper than in Massachusetts, I have come to the conclusion that in some localities the limit of safety is at least six or six and a half feet. On works where I have been recently, I have found that hydrants which have been carelessly placed by contractors have frozen. In some places on the St. Croix river, for instance, hydrants froze under circumstances which I have no doubt could have been prevented by proper care at the time of setting. If it is concluded to be desirable to place them above the frost line, they can be protected by packing, and we have made use of tan-bark with good effect. I don't know as I can add anything more, and will close by repeating that, as the result of my experience, I have come to the conclusion that as far as possible hydrants should be set below the frost line.

Mr. DARLING. — Had those hydrants which you spoke of as having frozen just been laid, or had they been laid a year?

Mr. ROGERS. — They had been laid one year, but the first winter was not very severe. They were set in a very clayey soil, perfect brick clay.

Mr. DARLING. — I have found the first winter after laying water-pipes, before the ground became fully settled, the frost would penetrate into the comparatively loose earth much deeper than it would after the earth became solidly settled. I have noticed that in several places where new works have been built.

Mr. KEATING. — I do not know that I can add very much to what has been said on this very interesting subject. I think the packing has a great deal to do with preventing freezing. I have been connected with works in a place where the soil is somewhat similar to what has been described, a very hard clay. In those works the hydrants were designed with a drip, but there were no sewers in the place. The first winter there was a good deal of trouble, and the hydrants had frequently to be pumped out. In some of the worst cases I had trenches dug to meet the hydrants, and filled the trenches up with stones, hoping the water could be run off in this manner; but the soil was of such a nature I found the trenches would fill with water, and eventually all the hydrants had to be plugged and pumped out. They were set five feet under ground. After they were plugged and the water was pumped out, we never had any further trouble with them. We used ashes for packing, and I think the frost in that place — it was in Nova Scotia — goes as deep as in any town in New England. I don't know that it is necessary to go very much deeper than five feet; I never found it so, — that is, to the top of the pipe, even though the frost may penetrate to a greater depth; that is, if you are careful about packing the hydrants. I have known the frost to go six feet and a half, and the hydrant, — where it was properly packed, — not to be affected.

I may also say that I have had some experience with hydrants being used for

general purposes, for street sprinkling, and for flushing sewers, etc., by the different departments. It is a difficult matter to deal with in some towns, where it would involve an enormous expense to put in the number of standpipes which would be required. The city of Halifax is built on rock, and of course it costs a great deal of money to lay pipes. We are as careful as we can be in selecting the men who use the hydrants, and I cannot say we have experienced very much trouble when the men have been careful about using them, though some of the hydrants have been damaged by careless handling.

Mr. HOLDEN. — I have had very little trouble with frozen hydrants, although I have been in places where the frost penetrates about as deep as anywhere in New England. When I set a hydrant I use thirty or forty brick, and build up a loose wall around the front and sides of the hydrant, which serves as an air-chamber, and it has always worked well. Winter before last, when my neighbors were complaining of frozen hydrants, I don't know that I had one freeze all winter. Whether it was owing to the nature of the soil or to this loose chamber around the hydrants, I cannot state. In running to a hydrant from the street main, I am always careful to have the hydrant on the short side of the street, if possible; that is, on the same side the main lies; and whenever there is a ledge, I always cover the supply running from the main to the hydrant with a plank. That serves to make a sort of an air-chamber, and it has always kept out the frost. I don't know whether that would work well in other cities, but it has worked well with me.

Mr. STACY. — I have often thought it would be a pretty good idea if some of our smart hydrant makers would design some automatic plug or drip which could be worked at or near the surface. When I have a chronic case of a hydrant troubled with surface-water, I plug it up, as my friend on the left (Mr. Clark) does, though I don't do the same as he does in the spring, — open it again, but I let it stay there. Whenever the hydrant is used I pump it out. We build a well with small cobble-stones around our hydrants when we set them, and sometimes it does a great deal of good and sometimes it doesn't. The only effect it has on some of our hydrants is to give a chance for a little more water to collect around the foot of the hydrant from the outside; there can't but a little get from the hydrant out of the drip. When I find such a case, I plug the hydrant and let the plug stay in. I don't believe in trying hydrants much, if they are all right, in cold weather, but I believe we ought to know whether they are right or not; and if they were so constructed we could find out whether they are all right or not without disturbing them, I think it would be a good thing, and we would be safe in trying them. There are a good many places, probably, where there is trouble from surface-water, and some places where it is chronic, and then of course all there is to do is to plug up the hydrants. It would be very nice if we had a plug or drip that could be worked from the surface or near the surface. Another thing which has occurred to me is, that where a hydrant has a good drip, it would ensure its working if there was not only an automatic drip, but an automatic vent at the top that would open when the drip opened, and close when it closed. In some cases I think that would obviate a frozen hydrant by giving a chance for the air to get in. Some of these hydrant makers make their fits so nice that there is no chance whatever for air to get in.

Mr. PARKER. — In St. Paul they set many of their hydrants in brick vaults.

They build a brick vault around the hydrant and have a cast-iron cover to it, and the vault is large enough so a man can go down into it and attend to the drip, or make any necessary repairs without any excavation. I suppose that plan was adopted because they have a great deal of ledge there. It struck me at the time that it was a very good idea, but rather expensive.

Mr. EGLEE. — I should like to mention a practice which prevails in the city of Rochester. In that town the hydrant is packed with masonry, going around the hydrant on both sides and leaving only the joint open. Inserted in the masonry is a tile pipe which leads from the drip to at least fifteen feet away and terminates in a stone well; and where there is surface-water in the ground it is let into the sewer.

Mr. WINSLOW. — My experience has been very small in connection with this matter. I have some hydrants which are set in very wet ground where the water stands almost all the time. One hydrant in particular has been a puzzle to me. In years before it would freeze every winter, but a year ago last winter it did not freeze. During the coldest of the weather that year the chief engineer of the fire department and myself inspected the hydrants which we thought were most liable to freeze, and among others we inspected that and were surprised to find it free, not a particle of ice in it. This last winter it caught slightly; not enough so but what it could be opened easily. All the others went through the winter all right except one. That was one which had been lowered, on account of its having been frozen before, a foot, so it was six feet and a half from the top of the ground to the top of the pipe. That hydrant was tried one day with the others and found to be all right; but the next day there was a fire and it became necessary to use that hydrant, and we couldn't get the hydrant open. I told the engineer after that I thought the best thing we could do was to let the hydrants alone. Our practice has been to put the hydrants below frost line, and we have found we would have no trouble in gravel if the pipe was five feet deep; in sandy soil we put them down six feet and six and a half, and we have no trouble whatever with frozen hydrants, excepting in the two or three cases I have mentioned. My method of preventing hydrants from freezing is to put them below the frost line.

Mr. CLARK. — Before this subject is left I would like to make an inquiry. I have seen in the papers a cut representing two pipes running from the main to the hydrant, the idea apparently being that the water would flow from the main up to the hydrant, and then back again; and I would like to know if any gentleman here has had any experience with an arrangement of that kind.

Mr. BRACKETT. — I have had no experience with it; but there was exhibited at the last annual convention a model of a hydrant connected with the main by two pipes, and in the model the water circulated in the pipes. Whether it would in practice I couldn't say. It would seem to me that a much more economical way of preventing the freezing of a hydrant would be to add one or two feet to the length of the hydrant-barrel rather than to add fifteen feet to the connection pipe, with the double branch which would be necessary at either end. In fact, I would emphasize that point of making the hydrant-barrels long enough to carry the hydrant below the frost. All of the hydrants in Boston, except the Lowry hydrants, which are set on the main, are now set lower than the main.

Mr. CONANT. — Most of the gentlemen who have spoken here to-day have

related their experiences in connection with public works. I am running a private company. The town has a fire department, and I would like to inquire if there is anything that can be done to keep the firemen away from the hydrants, or to regulate things so they will let them alone except when they are required for fire purposes? They seem to delight, especially if they have had a little something besides water, to take a hydrant-wrench and go fooling around the hydrants; and they will open them, and won't stop for them to drip, and consequently we have had trouble. In fact, we have had much more trouble in keeping the engineers from opening the hydrants than from any other one thing. If I say anything to them they will retort, "Oh, you are afraid of our wasting the water," and they are very independent. Of course we desire merely to protect the property of the town, but we can't help their using them.

Mr. DARLING. — I recommend you have a prohibitory law passed there. [Laughter.]

Mr. BRACKETT. — In Boston the firemen never open a hydrant except in case of fire. When they wish to give an exhibition of the department, they obtain permission of the water department to use the hydrants.

On motion of Mr. Coggeshall the Convention then adjourned to 7.30 P.M.

EVENING SESSION.

In the evening, Prof. J. E. Denton, of the Stevens Institute of Technology, Hoboken, N.J., addressed the Association on "The best economy attained by the modern high-expansion type of pumping-engine compared with the best record of Cornish pumping-engines during the time of Watt, as recorded by the Wicksted experiments."

The lecture was illustrated by lantern views.

THURSDAY, June 13.

MORNING SESSION.

The Convention was called to order by the President.

Superintendent Charles E. Bolling read a paper describing the water works of Richmond, Va., which was discussed by Mr. Clark, President Nevons, and Mr. Babcock.

Superintendent George F. Chase, of Taunton, Mass., then read a paper entitled "Friction in the collection of meter rates."

Water Registrar Albert S. Glover, of Newton, Mass., read a paper entitled "Water-works Records."

Mr. Coggeshall, in behalf of Superintendent Kieran, invited the members of the Association to a horse-car ride about the city at the close of the morning session.

Mr. COGGESHALL. — At a meeting of the Executive Committee yesterday it was voted to recommend to the Association the adoption of the following order: —

"*Ordered*, That the Executive Committee recommend to the Association that the junior editor be paid a salary of $300 for his services during the coming year, such salary to include travelling expenses."

On motion of Mr. Hall the recommendation was adopted, and it was voted to pay a salary of $300 to the junior editor.

ELECTION OF OFFICERS.

The committee appointed to nominate officers presented the following names for the consideration of the Association: —

President. — Dexter Brackett, Boston.

Vice-Presidents. — W. M. Hawes, Fall River; W. B. Sherman, Providence; Geo. P. Wescott, Portland, Me.; H. G. Holden, Nashua, N. H.; W. H. Richards, New London, Conn.; F. W. Wilder, Woodstock, Vt.

Secretary. — R. C. P. Coggeshall, New Bedford, Mass.

Treasurer. — Hiram Nevons, Cambridge, Mass.

Senior Editor. — Desmond Fitz Gerald, Boston, Mass.

Junior Editor. — Albert S. Glover, West Newton, Mass.

Executive Committee. — Frank E. Hall, Quincy, Mass.; Edwin Darling, Pawtucket, R.I.; H. W. Rogers, Salem, Mass.

Finance Committee. — H. F. Whittier, Lawrence, Mass.; G. E. Winslow, Waltham, Mass.; F. A. Andrews, Nashua, N. H.

On motion of Mr. Darling the Secretary was instructed to cast the ballot of the Association for the gentlemen whose names had been read, and he having done so, the President declared them elected officers for the ensuing year.

THE PLACE FOR THE NEXT ANNUAL CONVENTION.

Mr. Brackett. — I think it would be well for the Association to select a suitable place for its meeting without regard to any invitation which may be received. I do not believe in waiting for an invitation, but think it better for the Association to select some place where good hotel accommodations can be secured, and go there and pay their own bills. I will, therefore, make a motion that a committee of three be appointed by the chair to consider and report a place for holding the next annual meeting, and also a place for the fall meeting.

The motion was adopted, and the President appointed Messrs. Brackett, of Boston, Hall, of Quincy, and Parker, of Burlington, Vt., as the committee.

President Nevons then introduced Mr. Abbott, of New York City, formerly of South Bend, Ind., who gave some interesting incidents of his service as superintendent of water works at the latter place.

COURTESIES EXTENDED BY FALL RIVER FRIENDS.

Mr. Hawes. — The members of the Association are invited to visit our high-school building at the close of this afternoon's session. To those of you who have not seen it, I will say it is a very fine building, probably the finest school building in the United States, if not in the world. It is no fault of the city of Fall River that we had it, but a big and noble hearted woman gave us this institution as a monument to her departed son. It is fully equipped with apparatus for all kinds of study, — geographical, philosophical, chemical, mechanical, astronomical, and all other kinds of "icals," — and it is really worth your time to visit it. It is only a

short distance from here, and we can easily walk to it. In the hall in the upper part of the building is a marvellous picture which her son purchased in Germany, — Kaulbach's latest work, "The Era of the Reformation," costing him in this country over $35,000. To-morrow our city government invites you to take your breakfast early at your own expense, and then to take barges at our expense, and go to our pumping-station. We feel very proud of it, for it never looked so well before, and it may never look so well again, and we want you to see it now. After examining it, you will enter the barges and proceed to the wharf, where you will take a steamer and go down the bay for a fish dinner, with plenty of clams for all of you except the President, and a sail, returning in season for you to take the afternoon train to Boston.

On motion of Mr. Coggeshall, the invitation was accepted with thanks. The Convention then adjourned to afternoon.

AFTERNOON SESSION.

The convention reassembled at 2.30 P.M.

On motion of Mr. Brackett, the report of the Committee on Badges was taken from the table, and on motion of Mr. Darling, the badge recommended by the committee was adopted as the badge of the Association.

REPORT OF COMMITTEE ON LOCALITY OF NEXT CONVENTION.

Mr. Brackett. — The committee, after considering the question of a suitable place for holding the next annual convention, have concluded that either Burlington, Vt., or Portland, Me., would be desirable, and would suggest that a vote be taken by the Convention as to both of these places.

After some discussion, the members who desired to express their preferences voted as follows: For Burlington, 4; for Portland, 6; for Worcester, 10.

And on motion of Mr. Stearns it was voted that the next convention be held at Worcester.

Mr. Brackett. — The committee think it would be well to leave the selection of the place of the fall meeting to the Executive Committee, with the suggestion that if any members have any preferences, they will communicate them to that committee.

On motion of Mr. Stearns it was voted to accept the report of the committee, and adopt its recommendation.

Later in the afternoon session Mr. Coggeshall brought up the matter of the place for holding the next annual convention, and said: —

"It seems the vote which was taken early in the afternoon — which was not a very full vote — does not meet with the approbation of many of the members, who seem to think that Worcester is not exactly the place for us to meet. Now, I want to have a successful convention next year. I am willing to go anywhere; I am sure I shall have a good time, but I want to go to a place where we shall certainly have a full attendance. And in order that a place may be selected that will, perhaps, prove more satisfactory, I move that the vote that was passed whereby we decided to go to Worcester be reconsidered."

The motion was adopted unanimously.

The PRESIDENT. — I sincerely hope we will hold our meeting in Portland. It is a first-class place to go to. There is a large harbor there, and plenty of water. We are not obliged to ask permission from the city authorities. We have money enough to pay our bills, there are good hotels there, and lots of things to be seen, and we can have a first-class time. Worcester is a good place in which to hold political conventions, but I think Portland will suit us better for a water-works convention. It is a place easy of access; we can go on the cars, or those who prefer can go on the boat at night, and be there all ready for business the next day.

On motion of Mr. Fitz Gerald, the Convention voted to go to Portland.

Prof. W. T. Sedgwick, of the Massachusetts Institute of Technology, then read a paper entitled "Recent Progress in the Biological Analysis of Water." The paper was discussed by Messrs. Drown, Stearns, Fitz Gerald, Noyes, Allis, and Chase.

On motion of Mr. Brackett, the thanks of the Association were extended to Professor Denton, for the instructive and interesting lecture given by him on Wednesday evening.

Adjourned to 7.30 P.M.

EVENING SESSION.

At the opening of the evening session, the following-named gentlemen were elected members of the Association: —

ACTIVE.

Millard F. Wright, Superintendent, Lowell, Mass.
Ansel G. Hayes, Assistant Supt., Middleboro', Mass.
Benj. P. Hale, Water Registrar, Haverhill, Mass.
Edward T. E. Lansing, Little Falls, N. Y.

ASSOCIATE.

William Wolfendale, Agent, "Water-Works Supplies," Fall River, Mass.
John Hattersley, "Common-Sense Packing," Brooklyn, N. Y.
Charles H. Eglee, "Contractor," Flushing, N. Y.
N. F. Ryder, "Varnish Manufacturer," Middleboro,' Mass.
Portsmouth Wrench Co., Boston, Mass.

A letter was received from Desmond Fitz Gerald, declining to accept the office of Senior editor, and, on motion of Mr. Hall, the Executive Committee was given full power to act in filling the vacancy in the office of Senior editor.

HOW TO PREVENT MAINS FROM FILLING WITH SEDIMENT.

The President called up for discussion the topic, "Suggestions as to the best methods to prevent mains from filling with sediment," and invited Mr. Darling to address the Convention.

Mr. DARLING. — I have had very little experience in this direction. My mains are very clear of sediment. The system we have in Pawtucket, of taking the sediment out of the water before it is sent into the pipes, accomplishes the purpose, and we do not get any bad results from sediment in any form or nature. I remember on one occasion a gentleman who lives on a dead end complained

to me that the pipe was all filled up with silt and sediment, and the water was terribly bad. I told him that to satisfy him we would go down and take the plug out at the end of the pipe, and show him whether he was correct or not. When the men had got it dug up and the plug knocked out, he saw there was no sediment there at all, which convinced him he was entirely wrong, and settled that question. I presume there may be people here who have trouble with sediment, but so far as I am concerned, I don't know anything about it.

Mr. KEATING. — The difficulty in Halifax is with incrustation in the water-pipes, and not sediment. In other places, where there were small works, sediment has been liable to collect, and I suppose the usual method of removing it is the one I adopted, simply to put in blow-offs at suitable places and blow it out. Our method of removing the incrustation in pipes, and I suppose sediment can be removed in precisely the same way, is to put a scraper through. The scrapers are run by the power of the water in the pipe itself, and where they are properly constructed and handled they will take out everything in the pipe, unless it is lead which has run through and sticks too far into the pipe. If it projects far enough it may possibly stop the scraper, but, as matter of fact, I haven't found any difficulty except in one or two cases. If it doesn't project more than half an inch or three-quarters of an inch, the scrapers will pass. The longest distance I have so far operated one of these machines is five miles and a half, which I think is about long enough. We put in catch-boxes at intervals varying from half a mile to a mile, according to the configuration of the ground, but in practice I have found it was not necessary to have so many.

Mr. HAWES. — My friend, Mr. Jones, suggests the best way to prevent the mains from filling with sediment is to keep it out of the pipes. We had an alarm of fire yesterday morning, and towards noon, as I was riding along, a gentleman hailed me and wanted to know what kind of stuff we supplied through our water-pipes. I told him anything he wanted, — water, fish chowder, or anything else. [Laughter.] He brought out an iron bolt and a nipple, and said both of those came through the hydrant that morning. I told him there was no extra charge for them; he could have them, and welcome. [Laughter.] Now, if we had kept them out they wouldn't have been in the pipes; so I think my friend Jones' suggestion, that the best way to prevent the accumulation of sediment is to keep it out of the pipes, is a good one.

PUBLIC AND PRIVATE WATER-WORKS.

The next topic for discussion was, "Should the public and public corporations be chiefly responsible for the sins of private corporations, and which, all things considered, is most conducive to public interests: Water-supply furnished by municipalities or by private corporations?"

The President called on Mr. Hall, of Quincy.

Mr. HALL. — I have but very little to say. In answer to the first part of the question, speaking from the standpoint of a manager of a private corporation, I should say, with my present experience, that if private corporations commit any sin the public is responsible for it. To commence with, private water companies are usually given a charter by the Legislature, granted because certain inducements are held out by representatives of the community desiring a water-supply.

Feeling unable to take hold of it, or unwilling to take hold of the matter themselves as a town or a community, these inducements are offered to parties to make an investment for the sake of an investment, with a view of obtaining a return, of course. Among other things, it is customary for a town or a city to agree to take a certain number of hydrants at a stipulated price. That is so much income assured to commence with. Every water-works engineer well knows the difference in the cost between furnishing a supply for domestic purposes alone, and furnishing a supply sufficient for fire protection. Consequently, from the inducements that are offered to the projectors, a larger plant is established, larger mains are laid, making an extra cost for the works.

When it comes to the case in hand, numerous difficulties are encountered. In the first place, it is a private corporation, and they are never doing their work in a satisfactory manner to all the public; although I claim that the work done by private corporations, as a rule, is done by men who put their money into the works for an investment, and it is as much for their interest to do good work as it is for a city to put in good works which are to be controlled by the city. When the works are built many people suppose that the hydrants are for them to use just as they see fit; firemen are to play with them whenever they feel inclined; if a man wants to water his garden he thinks he has a perfect right to go and open a fire hydrant and connect the garden hose with it; or if he wants to do a little plastering he thinks he can open the hydrant to get water to mix the mortar with; or if there has been no rain for a few days he thinks he can go and get a few tubs of water to do washing with. But when he finds out that the hydrants are for no such purpose, then there is music in the air. The result is, this increased cost of the investment has not yielded the returns which were anticipated, which the company had reason to expect, and the question of future extensions comes up, and it gets to be a question with the corporation, perhaps, whether they shall run pipes of sufficient size to furnish fire protection, or whether they shall run pipes for domestic purposes alone. Taking all things together, in many cases the supply that is furnished, I think, looking wholly from the financial standpoint, is furnished cheaper to the community, especially to a small community, — I don't know how it would be with a large community, — by a private corporation than it would be by works under public control. That is all I think of to say now. I shall be glad to hear from some one else before I attempt to say anything more.

Mr. HAWES. — "Should the public and public corporations be chiefly responsible for the sins of private corporations, and which, all things considered, is most conducive to public interests: Water-supply furnished by municipalities or by private corporations?" I have had this paper about three weeks, and I haven't got that question clean through my head yet. [Laughter.] If any of you can understand it, I should like an explanation before I start. "Should the public and public corporations be chiefly responsible for the sins of private corporations?" No. Every tub must stand on its own bottom. [Laughter.] This very strongly hints that your private corporations are tremendous sinners, and you want to shift the responsibility of that sin on to the public. That is what I should judge by the way it reads. Now, that can't be done. Any man who sins must take the consequence of it. A public corporation and the public may be the sufferers from the sins of private corporations, but they cannot be responsible for your sins. You hardly ever saw a man who had committed a sin who didn't

want to lay it on to somebody else when he was found out. You never saw a man who was driving a nail strike his finger but what he would blame the man who was next to him, or if there wasn't anybody there he would blame it on the hammer. [Laughter.] It wasn't his fault, of course! We are all perfect, we start that way, and we think we can't be anything less. Now, I say that it is my opinion that the public and public corporations should not be responsible for the sins of private corporations; and I am sorry that the man who wrote that question should think it necessary to accuse the private corporations of being such sinners.

"And which, all things considered, is most conducive to public interests: Water-supply furnished by municipalities or by private corporations?" I say, in my opinion, emphatically, water-supply furnished by municipalities. Now, while our friend, Mr. Hall, tells us it is the object of private corporations to have everything all right, still there is a selfishness prevalent in all our natures, a desire to make money out of private speculations. Water-supplies owned by private corporations are generally private speculations, and although they may want everything right, they are very apt to buy about the cheapest pipe they can buy to make them right, and about the cheapest material in every way to make them right. And they may be all right enough to start off with, but they are not generally supposed to be; they don't have the reputation of being of a character that lasts and wears well. But when the water is supplied by municipalities it is generally supplied through water commissioners, or through some committee who feel that they have a right to spend the public money a little more liberally than they would their own, and therefore they are likely to lay out a better plant on the start, and to see that it is kept up in better shape to the finish, in my opinion, than private corporations will do. Therefore I should say it was better for municipalities than for private corporations to furnish water. That will open the subject, gentlemen; now pitch into it. [Laughter.]

Mr. Codd. — I think one advantage of public works over private works is, that the town is likely to have extensions into the outlying districts made sooner if the town or city owns the works than if a private company owns them.

Mr. Keating. — I know one or two places where water works have been put in by private corporations which have not proved altogether a success. In my opinion it is most decidedly to the interest of the public that the municipalities should own their own works. If they do not build them, and they are built by a private company, the probabilities are they will have to buy them out at some time or other. And many of the companies that put in works, start with that idea, that the corporation will ultimately have to buy them out. That was the case in Halifax. The works there were first put in by a private company. They were designed on altogether too limited a scale, and the pipes that are now left of the original company's works I am taking out as fast as I can, for they are all too small. The entire works have been enlarged throughout. I know of another town in Nova Scotia, the town of Yarmouth, which is at present supplied by a private company. There was some hitch between the company and the town, and as a result the town haven't the right to use the hydrants at all, even in case of a fire. They have opened wells, and they have three of our fire-engines, and are obliged to depend upon them for fire protection. Of course

we all know that when a private company puts works into a place they do it for the purpose of making money out of it, and if they can't see a chance to make something they won't go into it. The people have to pay more, the rates will probably be higher for the water, and in all probability in a few years the corporation will be forced to buy the works out.

Mr. HALL. — I think Mr. Darling can give us some ideas on this subject.

Mr. DARLING. — I am like the good old deacon who was always ready to add his testimony whenever called upon. I am perhaps situated a little differently from most of the members. While our city owns the works, we supply three towns with water, so that, practically, we act as a private corporation. Our works were built by the city, and the outside works were also built by the city, and I will say that we endeavored to build as good works outside of the city limits in the adjoining towns as we did in our own town. The same rules and regulations that apply to our own people apply to those outside. We sell outsiders water on the same basis that we sell it at home, and we claim to sell water as low as any works in the United States similarly situated. We sell as low as six cents per one thousand gallons, and we pump against two hundred and sixty-eight feet head. Of course we don't claim to come alongside of a gravity works. Our outside customers fully appreciate what we do for them, and are perfectly satisfied, and I haven't any doubt that my friend Mr. Hawes' customers are perfectly satisfied with him. As a rule, I should agree with what he has said on the subject; but being situated as we are, and going outside to supply the adjoining places, we have thought it proper to do it.

Mr. HOLDEN. — I don't know, Mr. President, as I have anything particular to say with regard to this matter. I have been with a public company, and I am now with a private company, and I don't know but what both of the works have always been satisfactory to the consumers. I have had very little fault found in either place. I don't know that we have committed any sins on our works that the public are responsible for or complain about. At any rate, everybody has seemed satisfied to come in once a quarter and pay the water bills, and I certainly never have had any more trouble on private works than I have had on public works in that respect. Talking with our treasurer a little while ago, I asked him how much he ever had in bad bills. He told me he had been treasurer of the company for fourteen years, and there were less than forty dollars of bad bills outstanding.

Mr. BABCOCK. — It seems to me the key to this whole question is the rate of interest and the value of money. Municipal corporations have the advantage in that respect over private companies. There isn't a municipal corporation in the State of New York but what can borrow money at three per cent., and no private company can afford to put water works in that will produce less than six per cent. In one case the only revenue necessary to be derived is a revenue sufficient to pay the three per cent. and to provide for a sinking-fund; in the other case it must be at least six per cent. It seems to me that is the key to the whole situation in favor of municipal corporations.

Mr. FROST. — May I be allowed to say a word on this subject, for I am personally interested in this question, and I wish the discussion might be continued to some definite conclusion. I live, and own some property, in the town of Plainfield, N.J., which is just now agitated with the subject of water works. It

is the largest city east of the Alleghanies which is unprovided with water works, and for some years they have been trying to introduce them. The city contains a population of about 12,000, and it is entirely free from debt. The old New Jersey element in the population is strong enough to prevent any vote by the — I will call them New Yorkers, because the bulk of the business men who live there do business in New York, and come home at night, and they are all in favor of water works — the old resident population is strong enough to prevent any bonding of the city. The subject is just now under consideration by the council. There are a good many people who wish to take a franchise, and the question I wish to submit to the practical men here is this, as Mr. Babcock has just put it: The city is entirely free from debt, and they can borrow all the money they like at four per cent. It is estimated that the works will cost about $200,000, and they want to couple sewerage with the water, the whole to cost about $400,000. They haven't discovered any method yet by which they can give a franchise for sewerage, and really I would like to know if any gentleman here knows of any method by which it can be done. The only town I know of where it has been done is Shreveport, La. Samuel R. Bullock built the water works there, and they have a system of sewerage under franchises in connection with the water works. There are more water works run by the cities and towns in New England than in any other part of the United States. I believe Michigan runs altogether to private companies, and Wisconsin practically so. Now, what would the majority here say was the proper thing to do in Plainfield, — borrow the money at four per cent. and bond the city and build the water works, or give a franchise? That brings the matter right down to something practical. The population is not a manufacturing corporation, and there are no large establishments there which will desire to take the water. Most of the private houses are built on large lots, and the people do business in New York. Water would have to be supplied for fire purposes, but the franchise men have not seen any great revenue to be derived from the works, although they seem very anxious to get a franchise, and they say that in three or four years they think they will be able to get a return. This is a very interesting question to me, because I am personally interested in it, and wish the gentlemen here would bring it right home to themselves and say what they would do if they were in the council and had to decide whether it would be best to bond the city, or whether it would be best to give franchises, and let others take the risk. One of the gentlemen has spoken about the increased cost of materials, pipes, etc., for a fire-supply. Does any water company go to any extra expense to furnish fire protection? I believe the amount of water used in the city of New York for fire purposes is only about 6,000,000 gallons a year.

Mr. DARLING. — The gentleman must understand that you have to go to the expense of the hydrant service, whether you use the water or not. It is on the same principle that you insure your house. You insure it, and it doesn't burn down; you don't want it to burn down, but still you keep paying the insurance. It is on the same principle that the hydrants are furnished, and you have to go to the expense of putting them in. The water is of small moment.

Mr. FROST. — I did not consider it in that way, but only with regard to the size of the pipes. Of course I can see it costs as much for the hydrants whether you have fires or not.

Mr. DARLING. — As to the size of the pipes in any well-organized water works, I claim that to have good water works the first thing you want to do is to prove that you have good fire protection. If you satisfy the public whom you are supplying with water that you can put the water over any building in the town, they will have confidence in the water works at once; and I think that is one of the first and most important things to be considered.

Now, as far as the consumption is concerned, I maintain, as I did at the convention at Louisville, where I read a little article on that subject, that no private corporation would go into any town or city if it was to be entirely dependent upon the family supply, for it could not get enough out of it to make the works a paying institution. I have in my works, as I have said before, four divisions outside of Pawtucket — the East Providence, Central Falls, the Lonsdale and Valley Falls, and the Berkeley and Ashland division. There are large manufacturing interests there, and that is what induced us to go into those sections. I will say this, that if you have got a city of 35,000 inhabitants, with a fair supply of corporations, or a prospect of a good supply of corporations, the city could better afford to put in works than to let any one else in; but if you have got a city that is not so situated, it would be far better for you to let some private corporation in, if you can get them to come in, although I have my doubts of their coming in under the circumstances, unless you will agree to pay a hydrant rental far above what would naturally be expected. What I consider as a fair price, under favorable circumstances, is anywhere from $30 to $35. I contend you cannot afford to put in the extra pipes and the hydrants for much less than that price. The actual cost of the maintenance of them will be about that amount, even if you use but a little water, or, in fact, if you use none. That is the result of my experience as to whether I would have a private corporation come in or whether I would advise the city or town to build the works.

Mr. WILDER. — I would state that I represent a small private works, and that when we started we first thought of putting in merely a domestic service, and estimates were made upon that basis, and estimates were also made as to the cost of a fire-service connected with it. We found that the cost would be nearly double. We made a proposition to the town, which was accepted, to furnish the hydrants and put in the extra service, which would involve an increase in the size of the pipes, and also of the capacity of the reservoir, and base the price of the hydrant-rental to the town at four per cent., which is $26 a hydrant. The people in the village feel perfectly satisfied, and I have no doubt they will be glad to renew the contract when it expires.

Mr. CONANT. — As I understand the gentleman he cannot get a vote of the town to build the works, so they will either have to go without works or let a private company in. I have charge of a private company in a town which was in about the same fix. One village in the town wanted to put in works and the other village didn't, and they couldn't get a vote of the town to do it. So a contractor went there, made his contract with the town, and we now furnish them with hydrant and domestic supply. I don't know that there is any great fault found with us, and I am not aware that we sin very much; if we do, we are willing to be forgiven. Of course we want to make something out of it, if we can, and it is true, as has been said by one of the gentlemen, that while public corporations do not expect to more than pay the interest on the cost and to provide

for the sinking-fund, private corporations want to make a profit over and above the cost.

Mr. MORSE. — I want to say just a word. I represent a private water company in Haverhill, and we don't charge the city anything for water for fire purposes, yet we make a living all the time. As to liberality in laying pipes, I will state we put them anywhere where they will pay five per cent. on the cost, throwing in the water to the city. We don't charge a cent for fire purposes, and the city puts in its own hydrants.

Mr. FALES. — I will relate a little experience which I have had in the town of Tonawanda, which is one of the largest lumber ports in the world. The population is about equally divided as to nationalities, and when the question of putting in water works came up the situation was very much as the gentleman describes it to be in Plainfield, the voters being about equally divided in opinion. The matter was further complicated by the introduction of the question of sewerage. The drainage of the town was poorly provided for, and many people thought a system of sewerage should be introduced before a water-supply was put in. Finally a private company offered to make a contract with the town. The town is situated partially in Erie and partially in Niagara counties, with a population of about 6,000 in each village. The north side is, perhaps, a little more genteel than the other part of the town. We went to work first on the north side, and made a contract to put in six miles of main there. We agreed to furnish a perfect fire protection, and we allowed the members of the common council the right to say what size of main should be put in, and after settling that we were to put in as many fire hydrants on the six miles of main as the common council required. They thought ninety-seven would be enough; so we put in ninety-seven hydrants, and the contract was that after that we should receive for each additional hydrant $40 a year. We were to lay four hundred feet of pipe, and on every four hundred feet of pipe receive $40. After a time the south side accepted the proposition of the company, and they have eight miles of main. The contract was, they were to have as many hydrants as they saw fit; and we placed on that eight miles of main one hundred hydrants, and on each additional four hundred feet we were to put another hydrant and receive $40 a year. Our contract specifies that at any time when they think the works are not in shape to give perfect fire protection, we shall furnish them twelve hydrant streams at a perpendicular height of eighty feet. We have been called on twice to do it, and have performed the test to the satisfaction of the city authorities. We try to make the rate to consumers as low as it is in any town similarly situated, and so far no fault has been found. I think $40 is as cheap as any company can afford to maintain hydrants.

Mr. CONANT. — Do you pump the water or have gravity pressure?

Mr. FALES. — The contract with the town is for twenty years, or they can buy at any time they see fit. The water is pumped. The pressure is an even pressure of 40 pounds at all times, and the fire pressure is from 80 pounds to 120, and we carried it at one time to 135 pounds. The mains are Wyckoff wooden pipe, and we have never had a break at that pressure.

Mr. HALL. — I think the remarks of the members here to-night have demonstrated this: That many small communities are at present supplied with water by private corporations that otherwise would be entirely without any system of

water-supply, and would remain so for a long while if they had to wait for the supply to be put in by the town or the city itself. That seems to be the result of the experience of every one who has spoken as representing private works. That is the situation in the place I represent; and in several places that I have in mind, places that I have had occasion to visit within a comparatively short time, where they are agitating the question of a water-supply, there is decided opposition to the town taking hold and building the works. They couldn't get the town to vote to do it, but they have voted to contract with private companies to build works for them. I think private companies are doing a great deal of good, and many communities are receiving the benefit of a public water-supply which, without these private companies, would be without an adequate supply of water for domestic purposes, or for the purpose of fire protection.

Mr. Noyes. — This discussion has consumed considerable time; but I would ask the convention to excuse me if I say a word with particular reference to Mr. Frost's question as to the matter of selling a franchise for the purpose of providing a system of sewers for a place. I believe there are two places in New Jersey where they have a system of sewers with a regular fee for entrance and annual rentals, on the same principle as in the case of a water-supply. Then, as to his question as to whether Plainfield should be supplied by a private company or by the municipality itself, I think Mr. Babcock answered it in a nutshell, with this exception in favor of private works, that in the management of them politics can be kept out. That seems to me to be one objection, possibly, to municipal management; but if public works can be managed with the same sagacity and prudence as private works, the municipality should by all means own the works. Ordinarily a private company is organized to put in water works as a matter of business; and a contract with the town for hydrant rentals is practically equal to a good interest on the cost of the works. Many companies that are organized and works that are built to-day are on that very basis, and their bonds are sold on the market because the hydrant rental is equal to the interest on the bonds, and the works are generally bonded very closely to the full cost. The works are generally put in, — I do not say they all are, because there are many private works honestly constructed, — they are generally put in for the five or ten years during which it is supposed they will be run by the private company; and then the contractors, or the parties in interest, will work the politics of the town so as to sell the works at from thirty-three to fifty per cent. more than it would cost the town to have built them originally. The price of the works is made up not so much on the basis of the actual intrinsic value as on the income they represent. I have in mind one municipality that will soon be called upon to buy private works, and it will have to pay out inside of three years from thirty-three to fifty per cent. more than the works cost, and will have to rebuild two-thirds of the works.

CLOSING EXERCISES.

Mr. Noyes. — If not out of order, I should like to say one or two words with reference to our meetings during the past year. It has given me great pleasure to attend those meetings, and I think I voice the sentiment of every member who has had the privilege of attending them, in saying that they have been very interesting and profitable to us. This has been due largely, while, of course, in

some part to the exertions of the members, and the interest they have taken, to the earnest work and harmonious action of our officers, and especially to our President and our Secretary. And although it is out of order, as a general thing, to move a vote of thanks to two men who do their duty (and it is the duty of a man who takes an office to do all he can to enhance the interests of the association in which he takes that office), yet I do believe it is a proper thing for me at this time to move that a vote of thanks be extended to the President for the work that he has so earnestly undertaken, and has so successfully carried out during the past year. [Applause.]

Mr. DARLING. — Mr. President, I rise to second the motion. It was my fortune last year to hold the position to which the gentleman was elected at Providence. Owing to circumstances beyond his control he was not able to stay through the sessions of the Convention at that time and take the chair, as it had been customary for the newly-elected president to do. I, therefore, promised him that I would in his behalf accept the position for him, and make his inaugural address. That I did, agreeing at that time, as his representative, to perform the duties of the position during the year to the best of his ability, and for the best interests of the Association. It gives me great pleasure to say that he has confirmed what I said for him at that time, and that he has performed the duties of his office to the satisfaction, as I believe, of every member present. I take great pride in seconding the resolution.

The motion was put by the Secretary and adopted.

The PRESIDENT. — Gentlemen of the New England Water Works Association: I thank you heartily for this expression of your kind feeling towards me; but I think you have gone a little too far. I do not think the President would have amounted to much unless he had had such a man as this [pointing to Secretary Coggeshall] alongside of him, and working with him. [Applause.] And I would also recognize the earnest spirit of coöperation that has been shown by the associate officers and every member of this Association. I said in my opening address yesterday that I should never forget the honor that you conferred on me when you elected me your President, and I am still of that opinion, only a good deal more so. I am sure that every one of you has shown me the greatest courtesy, and a spirit of willingness to overlook all the deficiencies that I have exhibited in this position.

As most of you know, I attended the Convention at Louisville, Kentucky, and while there I was the guest at the banquet, and was called on to speak for New England and the New England Water Works Association. I told them it was a pretty big subject, for while I was there I had learned that New England was bigger than all the rest of the United States, — in this respect, at least, that the membership of the New England Water Works Association outnumbered the membership of the national association by thirty. Our members to-day number 306, and, as I said in my opening remarks, when our membership roll is called, we have an answer from the Provinces, from the land of the thistle and the heather across the water, and from all sections of this country. We have an institution that we should be proud of, and I do want to see it keep on and march steadily forward. I believe we are recognized now as a live institution. It is with a great deal of pleasure I resign my official position to the man you have selected to be my successor, for he is thoroughly in earnest in this work that we

are engaged in, and I know he will devote himself to the interests of the Association. [Applause.]

Mr. NOYES. — I want to be permitted now, Mr. President, to complete my motion, which, preferring not to put it myself, I made only in part. I move the thanks of this Association be extended to our worthy Secretary for his faithful and efficient work. [Applause.]

The motion was adopted.

Mr. COGGESHALL. — Gentlemen, without making any remarks I will simply thank you for your expression of appreciation.

Mr. HAWES. — I want to call the attention of members to the blue prints. We went into this some years ago, and we carried it out for two years with very good success, and I hope we will not give it up. I think it is one of the best things we have, and I do wish that next year members will take a little more interest in it than they have this year.

Adjourned.

FRIDAY, June 14.

EXCURSION TO NEWPORT.

This, the closing day of the Convention, was devoted to excursions and sight-seeing as guests of the city of Fall River. Under the guidance of Commissioner Hawes, Superintendent Kieran, and Registrar Robertson, the Association early in the forenoon took barges and inspected the water works and many other features of interest about the city. At eleven o'clock the party, augumented by many guests from Fall River and other places, boarded the steamer "Mt. Hope," specially chartered for their use, and steamed down the river; at Bullock's Point a landing was made for dinner, at the conclusion of which remarks appropriate to the occasion were made by Mayor Jackson and others, and ex-President Nevons and President Brackett extended to their hosts the heartiest thanks of the Association for the bountiful hospitality that had been extended to it during the three days of the Convention. Again boarding the steamer, the party sailed down to Newport, where an opportunity was afforded for an inspection of the new steamer "Puritan." Leaving Newport, the magnificent sail of the morning was retraced to Fall River, which was reached in time for the members to take the evening trains for their homes.

A very pleasant feature of the Convention was the musical contributions of Messrs. Pratt, Monroe, and Milligan, who not only sang from time to time during the sessions of the Association, but also gave very enjoyable concerts in the parlors of the hotel each evening, after the meetings were adjourned.

LIST OF BLUE PRINTS DISTRIBUTED AT THE CONVENTION.

1. Contractors Plant, Howland, & Ellis, Boston, Mass. G. E. Wilde, Supt., J. Frank Williams, C. E.
2. Derrick for Pipe Laying, R. C. P. Coggeshall, New Bedford, Mass.
3. Weymouth Water Works, C. J. Ries, East Weymouth, Mass.
4. Sample Page of Section Book, Norwich Water Works, C. E. Chandler.
5. Design for 6-in. Two Outlet Fire Hydrant. Capt. J. L. Lusk, U. S. A.
6. Chimney at Pumping Station, Pawtucket, R. I. Wm. B. Sherman.
7. Dam and Pumping Station, Pawtucket, R. I. Edwin Darling.

8. Method of Taking and Storing Water at Middleboro' Water Works, Joseph E. Beals.
9. Flexible Joint and Screen for Suction Pipe, Geo. A. Stacy, Marlboro', Mass.
10. Distribution System, Little Falls, N. H. Stephen E. Babcock.
11. Specimen Page of Service Book, Woodstock, Vermont. Frederick W. Wilder.

LIST OF EXHIBITS BY ASSOCIATE MEMBERS AT THE CONVENTION.

1. Hersey Meter Co., Boston, Mass., Water Meters.
2. Chapman Valve Mfg. Co., Boston, Mass., Hydrants, Gates, and Valves.
3. Walworth Mfg. Co., Boston, Mass., Water Faucets, Plumbers' Tools, and Hall Tapping Machine.
4. Ross Valve Co., Troy, N. Y., Fluid Pressure Regulator and apparatus for regulating steam-car heating.
5. Geo. E. Winslow, Waltham, Mass., Reservoir Indicator and Recorder.
6. R. D. Wood & Co., Philadelphia, Pa., Photos. of Hydrants and Valves.
7. Tuerk Hydraulic Power Co., N. Y., Water Motors.
8. Builders' Iron Foundry, Providence, R. I., Globe specials.
9. Union Water Meter Co., Worcester, Mass., Rotary and Piston Meters.
10. Whittier Machine Co., Boston, Mass., Samples of Service-pipe.
11. Waste Water Prevention Co., N. Y., Thomson Water Meters.
12. Portsmouth Wrench Co., Boston, Mass., Hub Shaking Grate.
13. Locke Steam Damper Co., Salem, Mass., Steam Damper.
14. Common Sense Metallic Packing Co., Brooklyn, N. Y., Packing.
15. Galvin Brass and Iron Works, Detroit, Mich., Hydrants and Valves.
16. American Frost Meter Co., Boston, Mass., Meters.
17. H. R. Worthington, N. Y., Photos. of Pumping Engines.
18. Asbestos Packing Co., Boston, Mass,, Packing.
19. Peet Valve Co., Boston, Mass., Valves.

REGISTER OF THOSE IN ATTENDANCE

AT THE

FALL RIVER CONVENTION, JUNE 12, 13, 14, 1889.

ACTIVE MEMBERS.

Solon M. Allis, Superintendent Water Works, Malden, Mass.
Stephen E. Babcock, Hydraulic Engineer, Little Falls, N. Y.
George E. Batchelder, Water Registrar, Worcester, Mass.
Charles H. Baldwin, Boston, Mass.
Joseph E. Beals, Clerk and Water Registrar, Middleboro', Mass.
Emmett C. Bennett, Superintendent and Secretary Water Works, Ticonderoga, N. Y.

Charles E. Bolling, Superintendent Water Works, Richmond, Va.
Dexter Brackett, Superintendent Eastern Division Boston Water Works, Boston, Mass.
George F. Chase, Superintendent Water Works, Taunton, Mass.
Jonas M. Clark, Superintendent Water Works, Northampton, Mass.
William F. Codd, Superintendent Water Works, Nantucket, Mass.
H. W. Conant, Superintendent Water Works, Gardner, Mass.
R. C. P. Coggeshall, Superintendent Water Works, New Bedford, Mass.
Byron I. Cook, Superintendent Water Works, Woonsocket, R. I.
F. H. Crandall, Superintendent Water Works, Burlington, Vt.
Lucas Cushing, Assistant Superintendent Water Works, Boston, Mass.
Edwin Darling, Superintendent Water Works, Pawtucket, R. I.
Nathaniel Dennett, Superintendent Water Works, Somerville, Mass.
Thomas M. Drown, Professor of Chemistry, Massachusetts Institute of Technology, Boston, Mass.
Horace L. Eaton, City Engineer, Somerville, Mass.
H. M. Fales, Superintendent Water Works, Tonawanda, N. Y.
G. B. Fitts, Superintendent and Water Registrar, Attleboro', Mass.
F. F. Forbes, Superintendent Water Works, Brookline, Mass.
Albert S. Glover, Water Registrar, Newton, Mass.
Robert M. Gow, Superintendent Water Works, Medford, Mass.
Frank E. Hall, Superintendent Water Works, Quincy, Mass.
Joseph C. Hancock, Superintendent Water Works, Springfield, Mass.
James H. Hathaway, Water Registrar, New Bedford, Mass.
William M. Hawes, Water Commissioner, Fall River, Mass.
Ansel G. Hayes, Assistant Superintendent Water Works, Middleboro', Mass.
Horace G. Holden, Superintendent Water Works, Nashua, N. H.
Horatio N. Hyde, Jr., Superintendent Water Works, Newtonville, Mass.
A. W. Inman, Wisconsin Construction Co., Boston, Mass.
David B. Kempton, Water Commissioner, New Bedford, Mass.
Patrick Kieran, Superintendent Water Works, Fall River, Mass.
George A. Kimball, Civil Engineer, Boston, Mass.
E. H. Keating, Engineer and Manager Water Works, Halifax, N. S., Canada.
Edw. T. E. Lansing, Civil Engineer, Little Falls, N. Y.
W. F. Learned, Civil Engineer, Watertown, Mass.
Augustus W. Locke, Civil Engineer, North Adams, Mass.
Joseph A. Lockwood, Superintendent Water Works, Yonkers, N. Y.
James L. Lusk, Captain Corps of Engineers, U. S. A., Washington, D. C.
A. E. Martin, Superintendent Water Works, South Framingham, Mass.
Charles W. Morse, Superintendent Water Works, Haverhill, Mass.
James W. Morse, Superintendent Water Works, Natick, Mass.
H. H. Lowe, Superintendent Water Works, Clinton, Mass.
William E. Nason, Superintendent Water Works, Franklin, Mass.
Hiram Nevons, Superintendent Water Works, Cambridge, Mass.
Albert F. Noyes, City Engineer, West Newton, Mass.
Weaver Osborne, Water Commissioner, Fall River, Mass.
F. H. Parker, Burlington, Vt.
A. G. Pease, Superintendent Water Works, Spencer, Mass.

John F. Philbin, Water Registrar, Clinton, Mass.
John F. Plunkett, Water Registrar, Marlboro', Mass.
George J. Ries, Superintendent Water Works, East Weymouth, Mass.
Walter H. Richards, Superintendent Water Works, New London, Conn.
J. W. Ringrose, Secretary Water Works, New Britain, Conn.
W. W. Robertson, Water Registrar, Fall River, Mass.
Henry W. Rogers, Superintendent Water Works, Salem, Mass.
G. A. Roullier, Superintendent Water Works, Flushing, N. Y.
A. H. Salisbury, Superintendent Water Works, Lawrence, Mass.
William B. Sherman, Mechanical Engineer, Providence, R. I.
George A. Stacy, Superintendent Water Works, Marlboro', Mass.
Frederick P. Stearns, Chief Engineer State Board Health, Boston, Mass.
George F. Swain, Professor of Civil Engineering, Massachusetts Institute of Technology, Boston, Mass.
Charles H. Swan, Civil Engineer, Boston, Mass.
Charles K. Walker, Superintendent Water Works, Manchester, N. H.
Joseph Watters, Water Commissioner, Fall River, Mass.
Frederick W. Wilder, Treasurer Aqueduct Co., Woodstock, Vt.
Horace B. Winship, Civil Engineer, Norwich, Conn.
George E. Winslow, Superintendent Water Works, Waltham, Mass.
Millard F. Wright, Superintendent Water Works, Lowell, Mass.
Richard R. Yates, Superintendent Water Works, Northboro', Mass. 73

HONORARY MEMBERS.

George H. Frost, Engineering News, New York City.
E. R. Jones, Boston, Mass. 2

ASSOCIATE MEMBERS.

E. L. Abbott, Water Waste Prevention Co., New York City.
Chas. F. Angell, Builders' Iron Foundry, Providence, R. I.
Randolph Brandt, Selden Patent Packing, New York City.
A. H. Brodrick, Chadwick Lead Works, Boston, Mass.
Albert A. Blossom, Whittier Machine Co., Boston, Mass.
J. M. Betton, Henry R. Worthington, Boston, Mass.
G. H. Carr, Union Water Meter Co., Worcester, Mass.
Jarvis B. Edson, Recording Gauges, New York City.
J. H. Eustis, Walworth M'f'g Co., Boston, Mass.
Chas. H. Eglee, Contractor, Flushing, N. Y.
Jason Giles, Chapman Valve M'f'g Co., Indian Orchard, Mass.
H. A. Gorham, Gilchrist & Gorham, Boston, Mass.
Jesse Garrett, R. D. Wood & Co., Philadelphia, Pa.
F. W. Hood, Superintendent American Frost Meter Co., Boston, Mass.
John Hattersley, Common Sense Metallic Packing Co., Brooklyn, N. Y.
John C. Kelley, National Meter Co., New York City.
Charles Lynch, Galvin Brass and Iron Co., Detroit, Mich.
L. C. Lamphear, N. E. Agent Davidson Steam Pump Co., Boston, Mass.
L. McHugh, Galvin Brass and Iron Co., Detroit, Mich.

W. H. Moulton, Union Water Meter Co., Worcester, Mass.
W. H. Marsh, Tuerk Motor Co., New York City.
G. A. Polsey, Sumner & Goodwin, Boston, Mass.
L. A. Palmer, Portsmouth Wrench Co., Boston, Mass.
N. F. Ryder, Varnish, Middleboro', Mass.
Edward L. Ross, Chapman Valve M'f'g Co., Indian Orchard, Mass.
William Ross, Ross Valve Co., Troy, N. Y.
L. W. Sumner, Sumner & Goodwin, Boston, Mass.
R. J. Thomas, Agent Hegeman & Oliphant Water Filter Co., Lowell, Mass.
A. W. Worthley, Manager American Frost Meter Co., Boston, Mass.
George Woodcock, Nathaniel C. Locke, Salem, Mass.
H. D. Winton, Assistant Superintendent Hersey Meter Co., So. Boston, Mass.
W. Webster, George Woodman & Co., Boston, Mass.
John H. Wells, Vacuum Oil Co., Boston, Mass. 33

GUESTS.

J. P. Bacon, Stenographer of Association, Boston, Mass.
Thomas Burke, Engineer Fire Department, Marlboro', Mass.
J. E. Denton, Stevens' Institute, Hoboken, N. J.
W. D. Doyle, Tax Collector, Marlboro', Mass.
H. A. Fish, Malden, Mass.
Geo. L. Gould, Malden, Mass.
X. H. Goodnough, State Board Health, Boston, Mass.
Fred B. Gleason, Marlboro', Mass.
John Hall, Water Commissioner, Lowell, Mass.
C. W. Kingsley, Cambridge, Mass.
G. Frank Monroe, Boston, Mass.
Willis J. Milligan, Boston, Mass.
James T. Murphy, Commissioner, Marlboro', Mass.
P. B. Murphy, Town Clerk, Marlboro', Mass.
Francis L. Pratt, Cambridge, Mass.
F. A. Peckham, Engineering News, New York City.
F. W. Sheppard, Fire and Water, New York City.
F. E. Stevens, Boston, Mass.
H. Q. Sanderson, Chairman Water Board, Springfield, Mass.
E. A. Stevens, Malden, Mass.
Wm. T. Sedgwick, Professor, Institute of Technology, Boston, Mass.
Frank W. Skinner, Engineering and Building Record, New York City.
Wm. P. Walpole, Fall River, Mass.
A. S. Welch, President Water Board, Lowell, Mass.
Mayor Jackson, Fall River, Mass.
Mayor Newhall, Lynn, Mass.
Mayor Hall, Taunton, Mass.
Mayor Clifford, New Bedford, Mass.
Mayor Wiggin, Malden, Mass.
Ex-Alderman Haughwout, Fall River, Mass.
Chief Engineer Davoll, Fall River, Mass.

City Messenger Crosson, Fall River, Mass.
Ex-Mayor Milton Reed, Fall River, Mass.
Judge Blaisdell, Fall River, Mass.
Ex-Congressman Davis, Fall River, Mass.
Frank Steavens, Fall River, Mass.
City Clerk Pike, Cambridge, Mass.
Alderman F. H. Teele, Cambridge, Mass.
President Common Council Bingham, Cambridge, Mass.
Mr. Howland, Cambridge, Mass.
State Senator Howard, Fall River, Mass.
William F. Harbach, Newton, Mass.
Edmund T. Wiswell, Newton, Mass.
City Clerk Leonard, New Bedford, Mass.
City Auditor Topham, New Bedford, Mass.
President Common Council Tucker, New Bedford, Mass.
Chief Engineer Macy, New Bedford, Mass.
Edmund Wood, New Bedford, Mass.

PAPERS READ AND DISCUSSED AT THE CONVENTION.

HYDRANTS.

BY

GEORGE A. STACY, Superintendent of Water Works, Marlboro', Mass.

Mr. President and Gentlemen: — In presenting this paper I do not expect to give you anything new or startling, but to give you a few ideas on hydrants, gained by a short experience in the management of Water Works in a country town; and if in the reading of this paper and its discussion, any facts are brought out that will be of value to any one, the ambition of the writer will be satisfied.

Knowing from experience that circumstances alter cases, this paper should be considered from a Marlboro' standpoint (as our friend Mr. Kingsley would say), a town of from twelve to thirteen thousand inhabitants, built upon hills and valleys; and the sub-soil being mostly of hard clay, a little gravel and quicksand, and an abundance of rock all over the town of about every kind and quality known to this section.

Our works were constructed on a liberal scale in regard to size of pipes, number of gates and hydrants. It has been my experience that for four or five months in the year the hydrants give me more care and anxiety than any other part of the works. These iron posts, standing like sentinels in our streets, seem of less importance than a hitching-post; but the fire-alarm sounds, the anxious citizen counts the box, and as the apparatus of the fire department comes rushing into position in a moment, this apparently useless and neglected post becomes a thing of great importance and interest, for it stands, perhaps, if it is in proper condition, between him and great financial loss or ruin.

Looked at in this light they are worth all the care and trouble it takes to keep them in proper order. As it is the unexpected that often happens, no hydrant on the works can be neglected; all must receive the same care and attention. For the fire-fiend, like other evils, seems to delight to attack us in our weakest spot, where we are least prepared to give him battle.

I find that there is considerable difference in the way hydrants are cared for on different works, and in the way and time inspections are made. I have made it a rule to thoroughly inspect them in the spring and fall.

In the spring I proceed in this way. I first screw up the caps on the nozzles to make them as near air-tight as possible, and then open the gates clear up and close them again.

This answers three purposes: it runs the nut over the screw twice, and removes any accumulation; it determines whether the gate spindle and screw work freely at all points; it also compresses the air in the hydrant, and when the gate closes and the drip opens, the compressed air forces the water out, and will clear out most any obstruction that has accumulated from the outside, except

where the hydrant stands near a tree, and a root grows into the opening, as I have found in one or two instances.

If the hydrant does not work right, we locate the trouble and remedy it, and then remove and oil the caps. After this I find the hydrant will remain in good condition all summer. In the fall the operation is the same, except that we thoroughly oil every part, overhaul the packing and renew it if necessary, and pump the water out, noting, of course, if the gate is tight.

We use in the service a twelve-inch wrench, and every hydrant is supposed to open easily with that, but I find this would not be long enough in some places.

I visited a town some time ago where the fire department had done a particularly good job on a bad fire, and looking about the hose-house I saw a double-end wrought-iron hydrant wrench twenty inches long. I asked one of the men what they did with that, and he told me that was their regular hydrant wrench, and they carried a three-foot piece of gas-pipe to go with it.

Seeing by my face that I did not quite credit his story, he went to a box on the apparatus and showed me the pipe, which was about three feet long, and large enough to slip over the wrench. The chief, coming in just then, confirmed the man's statement, and said he had used the three-foot wrench, and three men, to open some of the hydrants, but that they were working a little better.

I think there must have been something the matter with the hydrants, or the man that had charge of them. There is one thing that can be said in favor of these hydrants, if those who designed them intended that they should work with an ordinary wrench, they allowed a generous factor for safety to stand three men on a three-foot wrench.

There are many cities and towns which own their works that credit the water department with a certain amount of money for hydrants, watering-troughs, etc. This I consider right. Other places do not allow the water department anything for this service. This I do not consider business-like or just to those that manage the works. It costs a city or town a certain sum to maintain its several departments, and each department has a separate account, and in the annual reports each department is expected to show how its money was expended, and the amount of work done. I think every department should stand on its own merits, and be charged with every item of expense belonging to it, and credited with all its work; unless this is done you cannot have a true report.

In the change of grade or relocation of a street, the hydrants must also be changed to conform to the new grade or location. Now, to what account should the cost of this work be carried?

In some places it is probably charged to the street and highway account; but in others it is charged to the water department, and carried to either the maintenance, repairs, or construction account, and it does not belong to either of them.

If the highway department expend one thousand dollars on a street, and the water department two hundred, it has cost twelve hundred dollars to improve the street; but if the work done by the water department is charged to their account, the report of the highway department will show that it cost one thousand dollars, which is not correct; the actual cost is the same in either case, but the water works get the short end of the stick.

If you ask for an appropriation for the care and maintenance of hydrants,

some one will tell you that the water works are doing well enough; that it will increase the taxes, and that they are high enough already. Well, let us see about this. Suppose that the revenue from the works do not pay all expenses, an appropriation must be made to cover this deficiency.

Now, suppose you appropriate this money for the use of hydrants, and the public use of water generally, it would not increase taxes or cost any more, but the works would receive the credit that rightfully belongs to them. But take another case. Suppose the works are self-sustaining, and with an appropriation for hydrants you have a surplus of six thousand dollars; now, what becomes of it? It is not lost; it will go back into the treasury, and be appropriated to extend the works, or for some other public use. But some will say, We do not want any surplus. Then reduce the price on the first faucets. This will affect those that are the least able to pay the water tax, — the man of moderate means, the man that depends upon his daily labor for a living, and from whom a large percentage of the revenue comes that supports the works.

The appropriation for hydrants coming from the general taxation, each one will pay for their maintenance in proportion to the amount of the property protected. The works should receive credit for every fixture from which water is drawn: from the faucet in the cottage to the hydrants that protect our business blocks and factories. Most, if not all, builders of hydrants claim them to be anti-freezing. Why? Because the opening called "the drip" is below or on a level with the supply-pipe, and when the gate is closed this drip is supposed to be open and to let the water all out of the hydrant post to a level with or below the inlet-pipe.

I say supposed, because you cannot see whether it lets the water all out or not; you can only guess, and you are apt to guess too quick if the thermometer is down to zero. This drip is like some boiler attachments that I have known; like non-sticking safety valves, low-water alarms, self-acting boiler feeds, which act all right just long enough to gain your confidence, but when you begin to rely upon them they go on a strike, and refuse duty, and you are in trouble right away.

There is one attachment to a hydrant that I consider necessary to make it anti-freezing that I have never seen mentioned in any circular or advertisement of hydrant builders, and that is, a suction pump with hose that can be introduced in the nozzle down to the bottom of the hydrant, and a faithful man to work it to make a sure thing of an uncertainty.

I am aware that in places where the drip can be connected with a sewer, or in sandy soil, there is less trouble or uncertainty about this; but in very cold weather, after a hydrant has been used, if immediately the cap is put on, the chances are that the frost and moisture will make the top of the hydrant air-tight, and the water cannot escape be the drip ever so free. I have made it a practice to pump out all hydrants after being used in cold weather, and if we have been working at a fire for any length of time, I try them twice, and sometimes more; for after a hydrant has been used for some time, the ground around the post is apt to be filled with water, and will give you trouble if you do not get it out. The question is often asked, How shall we set hydrants so they will not be liable to freeze?

This depends something on the place where they are set. Mr. Parker, of

Burlington, has said that the way to keep pipes from freezing is to put them below the frost; and our venerable friend, Mr. Jones, of Boston, remarked at one of our meetings that, after his long experience, the only sure way he knew of to keep pipes that were exposed to the frost from freezing was to let the water run or keep the water out. As we cannot place the whole hydrant below the frost, we can place the branch-pipe and gate there, and as we cannot let the water run, we must keep it out of the post. This seems easy, but like many other things, is more easily said than done.

In Marlboro' the soil is very springy; in some places we find this condition of things on our highest hills as well as the lower land, and in the places where we find quicksand the water stands within two or three feet of the surface most of the year. The hydrant drips here are not plugged, and they have never given me any trouble; but some hydrants, situated from one hundred to one hundred and fifty feet above this place, have filled with water to a level with the surface, and unless plugged and pumped out would freeze the first cold night. We could probably have kept some of them from freezing by the use of salt or oil, but the corrosive action of salt on iron, and the bad effect of oil on rubber hose, makes the use of them undesirable; but there are times when heroic measures are necessary, and then oil, salt, or most anything is advisable until you can do better.

We have 245 hydrants on our works, owned by the town, all of one manufacture, and not one of these have ever stuck, leaked, or needed repairs from any fault of design, material, or workmanship, or caused a moment's delay to our fire department in getting water at any fire since thay were put in commission. A frozen hydrant is not a desirable thing to have on your works; just the fact of a frozen hydrant is not so bad, for you can very soon thaw it out, but a frozen hydrant and a fire in that vicinity at the same time is what makes the cold chills run down your back, and makes you wish you were out of town, and that somebody else had charge of the works; for it is very much like the way some people look at a lie or a theft, — it is not the act, but being caught, that troubles them the most.

During the cold weather of the winter of '87 and '88, that made the coal-dealers grow fat and your coal-pile look sick, and every superintendent in New England was praying for warmer weather, I had a little experience that convinces me that no ordinary care will insure you from frozen hydrants. During that cold spell I was testing hydrants every day and almost every night, and a hydrant wrench was my constant companion. One night I started for home about 12 o'clock, feeling sure that every hydrant was in working order. On my way, by mere force of habit, I dropped my wrench on to a hydrant that I had tested during the day, that had not been used, and I knew that the gate was tight; in fact, I would have wagered considerable it was all right and ready for business, for it had never given me any trouble; but I found it as solid as a rock. This puzzled me somewhat; there was nothing to do but to thaw, and pump it out, and I found the water in the post within one foot of the surface of the street; I put in a quart of oil, and went home a sadder, and perhaps a wiser man, and I began to think that you could not place much reliance upon anything, and hydrants in particular.

The next morning I found the hydrant all right, and a solution of the problem. The service-pipe that supplied the building opposite the hydrant run up the

hydrant trench that was blasted out of a ledge. The waste-pipe from the building froze up, and they let the water run under the building, as they left their faucet open a little to keep it from freezing, and the water followed the pipe down to the hydrant, and filled up the post; after this was remedied, I had no more trouble at this place.

There is some difference of opinion, probably, as to which make of hydrants is the best. We all try and make the best of what we have, and probably there is no one that has charge of hydrants of any kind, for any length of time, but what has found some defects, or thinks he sees where an improvement could be made. We all agree that a hydrant should be well proportioned, to deliver the maximum amount of water with minimum friction or loss of head, should be strong in all its parts, to stand the rough usage in the hurry and excitement of a fire, of pleasing design and interchangeable parts, and easy of access for inspection and repairs.

The Lowry hydrant set over a branch in the main, it seems to me, is one that would deliver the maximum amount of water with the minimum friction or loss of head; also its close proximity, the water circulating in the main is favorable to prevent its freezing. Situated in the street, it is also convenient to attach two or more steamers, and in places where pressure makes the use of steamers necessary; and under certain conditions, such as public squares, or streets with high and massive buildings, where it would be desirable to mass a large force to fight an extensive fire, it is preferable, perhaps, to any other.

But under most any other condition, a good post hydrant is, in my opinion, preferable. It is more easily found, all ready to attach, and get right to work.

In talking with one of the oldest engineers of the Boston Fire Department, and commenting on the many devices employed and the ingenuity displayed to reduce to the lowest possible terms the time required to get the men and apparatus to a fire, he said, "We used to be after minutes, but we are after seconds now." It does take time, and valuable time very often (although it is done very quickly), to find, remove the cover, and adjust the chuck on a flush hydrant.

A post hydrant can be easily found and attached to, and if placed near the corner of a street is almost as easy to attach two or three steamers as though it stood in the street.

It would be a very nice thing if somebody would invent a dial or indicator to place on a hydrant, with a pointer, which, standing one way, would say, "I am all right," and the other way, "I am stuck or froze up;" but we shall not get this very soon.

If I were to write specifications for a lot of hydrants, there are three things that I should insist upon, and these are: that the gate should close against the pressure, that the opening for the drip should not be below the top of the inlet-pipe, and that the gate-rod should extend down to the centre of the inlet-pipe, so that in moving the nut on top with a hydrant wrench you would move the whole rod. My reasons are these: the gate closing against the pressure, comes to its seat without shock or ram; the drip being on a level with the inlet-pipe holds the water in the base to the same height as the inlet-pipe, and if the hydrant freezes it holds the gate-rod so it cannot move. There is a certain amount of movement (or, to use a shop term, back lash) between the nut and screw, which allows the gate-rod to turn a little without starting or disturbing the gate, and the end

of a twelve-inch wrench will have a movement of from three to six inches back and forth, without bringing any strain upon the gate.

I try my hydrants in this manner: I place the wrench on the hydrant, and if it is frozen the rod will be as solid as though it was held in a vice; but if I can move the rod with the wrench, I am absolutely sure that the hydrant is all right, and I can test them as fast as I can walk along the street. By this method, if the hydrant is all right, you do not let any water into the post, start the gate, or disturb its condition; and in this case, like many others, I think it is a good thing to let well enough alone, which you cannot do if you are obliged to start the gate to determine whether it is frozen or not.

All hydrants will need considerable care and attention, in severe cold weather, to keep them in proper order, until we have a perfect hydrant; and we shall not get that until we have a perfect man to build it, and that will not be this year.

DISCUSSION.

Mr. RICHARDS. — I agree with all that Mr. Stacy has said with regard to the inspection of hydrants, and for the benefit of the water commissioners who may be here and those who may read the proceedings of this Convention, I desire to emphasize the uselessness of inspecting hydrants if you allow their use for filling watering-carts. The water commissioners ought to take that and reflect upon it.

Mr. BRACKETT. — In Boston this question of allowing the filling of watering-carts has been agitated during the past year. It had been the custom of the street and health departments to use the hydrants throughout the city for sprinkling the streets, and of the sewer department to use them for flushing the sewers. Contractors also were in the habit of drawing water from the hydrants when constructing sewers or other work, and the result was that some of the hydrants were found to be broken. About a year ago an order was issued that no one should use the hydrants without a permit. The health department is now granted permits to use them for filling their carts in connection with the street sweeping, and permits are given to a few of the employees of the sewer department for use in flushing sewers. The men who hold permits are obliged to show them to the police, and all police-officers are expected to stop and to report any person whom they find using a hydrant without a permit.

Mr. DARLING. — Mr. President, I might say a word, perhaps, on this subject. It is one of the interesting subjects we all have to do with in practice, and we find various difficulties arising, and conditions which we do not just like, with regard to the hydrants, especially if the water department is expected to keep the hydrants in proper repair and ready for use. In the winter time we have charge of the hydrants, the fire department simply using them when they have to, and not being expected to have any control of the hydrants under any circumstances. Of course it is impossible to prevent hydrants freezing under some circumstances. I never allow them to be opened in extremely cold weather. I think it is a dangerous thing to do, for if you open a hydrant in very cold weather, it will certainly freeze before it can be used again, so we have given up the idea of opening them in the winter. We take the chances. We inspect the hydrants late in the fall, in the beginning of cold weather, and take the chances, not touching them again until spring. For the past four years that has been our

rule, and there have been good results. We have found but very few that were frozen, and those were located in ground where the surface-water would get into the hydrant, and then in some cases we have found the hydrant-stem frozen up perfectly tight. Of course the firemen, when they came to it and found its condition, would leave it and go to the next one, and it would be reported to us, and we would thaw it out.

Some three years ago our town began the experiment of watering the streets, and it was a question whether they could afford to do it or not, — previous to that time it had been done by private subscription, — and they wanted to use the hydrants. I allowed them to do it if they would put on proper men to handle them, and we didn't meet with much inconvenience from it. But I was fearful that we would, and so I asked the city government to erect standpipes to supply the watering-carts. They did so, and we now have more than forty in the city. I took care, however, to get rid of the responsibility of locating them before this man's house or that man's house by generously leaving it to the highway department. [Laughter.] They located them where they pleased, and although there are those who object to them, still they remain there just the same. They had got to be somewhere, and the highway department adopted the plan of locating them as they would hydrants. We have had some complaint from men who objected to having hydrants in front of their houses. I remember one gentleman objected on the ground that if his house got on fire the department could not use the hydrant in front of his house, and so he preferred to have it somewhere else near by. But on the whole, the plan of locating the standpipes as we locate the hydrants has given general satisfaction, and I think it is the only proper way to do. I do not believe at all in allowing anybody outside of the water department and the fire department to interfere with the hydrants; and with us even the owners of private hydrants cannot use them without first coming to us and getting permits to open them.

Mr. Brackett. — I should like to inquire how far apart it is the practice of members to set standpipes?

Mr. Darling. — We put them from one thousand to two thousand feet apart, varying in different localities.

Mr. Clark. — I would say that we place our hydrants about eight hundred feet apart, as a general thing, but in the centre of the city we place them more nearly together. I would like to ask this question: What remedy is there for the filling of the valves of the hydrants with water where the water stands in the ground, and there are no sewer-pipes to take it away. We make a practice, when we find that is the case, to plug them up, and then open them again in the spring.

Mr. Brackett. — That, I think, is the universal remedy. There is one difficulty which is experienced with the Lowry hydrants, and that is, if the wastes are plugged, we are obliged to pump them out after rain-storms and thaws, because the water fills the boxes and flows over the tops of the hydrants which are open.

DESCRIPTION OF THE WATER WORKS AT RICHMOND, VIRGINIA.

BY

CHARLES E. BOLLING, Superintendent.

In the year 1830 the city of Richmond, with a population of 16,060 people, decided, by a vote of the citizens, to construct water works. The City Council engaged Mr. Albert Stein, formerly a resident of Philadelphia, to prepare a plan and estimate of the cost of the works. A brief description of the city is necessary to clearly understand the situation. Richmond is on James river, at the head of tide-water. The topography of the site is exceedingly varying, consisting of a succession of hills and valleys, with elevations differing as much as one hundred and fifty-five feet. From the head of tide-water the river channel rises rapidly along a rocky bed, and within the distance of one mile and a quarter the water has attained an elevation of forty feet above mean tide. At this time a portion of the James river and Kanawha canal had been constructed along the northern shore of the James, and its water-surface was eighty-three feet above tide. At this point Mr. Stein selected a site for the pump-house, and recommended to use the water in the James river canal as a power, the surface of the canal being about forty feet above the proposed site. Subsequently the plan was changed, and water was obtained from a small fore-bay at the river, parallel with the canal and below it, and about 500 feet along. This fore-bay was supplied with water by means of a wooden dam, built on the rock ledges, and furnishing a head of ten feet. Here Mr. Stein erected a pump-house and pump. The water-wheel and pump were furnished by William Kemble, of New York. The wheel was a low breast wheel, and worked a double-acting horizontal pump of 400,000 gallons capacity in twenty-four hours. From the pump-house an eight-inch water main was laid under the canal to the reservoir, situated on a hill 2,400 feet distant, and 160 feet above the pump. The reservoir was 194 feet by 104 feet by 10 feet 8 inches deep, and was divided into two equal compartments by a brick wall; the enclosing banks were clay, and its capacity was one million gallons. In one compartment a filter bed, 32½ feet by 16 feet and 3 feet above the bottom of the reservoir, was constructed. The bed consisted of layers of coarse gravel at the bottom, the finer gravel and sand on the surface. The water by means of the pipe arrangement was to be forced upward, and finally find its way over the division wall into the distributing compartment. For the purpose of cleaning the bed, it was so constructed that water could be admitted from the surface, and wasted through the pump-main by means of a *waste* branch into a ravine. Mr. Stein stated at the time that this was the largest filtering bed in the United States; also that he was doubtful of its proving successful. The surface of the water in the reservoir was eight feet higher than any point in the city, and water was conducted to the city by means of a supply main 10 inches in diameter, 6,175 feet long. This main was estimated to deliver 400,000 gallons in twenty-four hours, or, according to Mr. Stein's calculations, furnish water for 4,000 families, computing the daily consumption to be 100 gallons per family. From the terminus of the 10-inch

main numerous distributing pipes of small diameters were laid, and fire hydrants put in at convenient points. The total cost of the works, — pumps, reservoir, pipes, etc., — exclusive of the dam and fore-bay, was $76,860. The works were accepted by the city February 17, 1832.

In 1833 another water-wheel and pump of the same design and capacity were erected, and another eight-inch water main laid from the pumps to the reservoir. In 1835 the filter bed was pronounced a failure for the purpose of purifying the water, and its use abandoned. In 1839 the city bought the dam and fore-bay for the sum of $25,000; and five years afterwards replaced a portion of the wooden dam with one of stone. In 1843, the population then numbering 23,000, the reservoir capacity was increased to 7,000,000 gallons, by raising the banks of the old reservoir and adding a new addition. In 1848, the supply of water becoming limited, — the population was 25,716, 1,212 of whom were water-takers, — a new supply main, twelve inches in diameter and 6,175 feet long, was laid. In 1849 the pumps were again increased by the addition of two water wheels and pumps of the same design and a little greater capacity, and two eight-inch mains laid from the pumps to the reservoir. Five years elapsed before it was again necessary to make additions, when two pumps and wheels of the same design, but of a capacity of 2,264,386 gallons per day, were put up, and two twelve-inch mains laid to the reservoir. The water-takers at this time numbered 1,882; the total pumping capacity was 4,453,107 gallons in twenty-four hours, and the reservoir capacity 7,000,000 gallons. In 1860 a twenty-four inch supply main was laid from the reservoir to the city. No further additions were made to the works until 1873; the supply then becoming scarce, owing to the increased number of water-takers, the population being 56,800. During the years 1873 and 1874, under the superintendence of Emile Geyelin, two horizontal double-acting pumps, having seventeen inch cylinterets and six foot stroke, were erected. These pumps were run by a Jonval turbine wheel. Their capacity was estimated at three (3) million gallons in twenty-four hours. A steam-pump, constructed by Guild & Garrison, of Philadelphia, with a capacity of 800,000 gallons, was erected on the canal, near the old pumps, and a twenty-four inch main laid to the reservoir, into which the new water-power pumps and steam-pump discharged. Upon their completion the actual pumping capacity was 7,557,943 gallons daily, the consumption 2,517,477 gallons, and the rate *per capita* 44⅘ gallons. The city at this time was rapidly extending and being built up in the higher portions, differing in elevation very little from the site of the reservoir, and was supplied by mains laid along streets of widely differing grades, greatly limiting the supply to those living on the high points. The demand came for increased pressure. Up to this time no plan to meet the future wants and growth of the city had been considered or adopted, but step by step, as the population increased, pumps and mains had been added to meet the necessity.

Col. W. E. Cutshaw, city engineer, after numerous surveys and examinations, recommended a site and plan for a new reservoir, which was adopted by the council, and constructed under his direction during the years 1874 and 1875. The site was a high and level plateau, about one mile west of the old reservoir, and two-thirds of a mile from the river, conveniently situated for a new pump location, which would have to be selected. The new reservoir is rectangular in shape, and contains 40,000,000 gallons, and is divided into two equal compart-

ments by a division bank. The banks are twenty-four feet high, and are composed of good puddle clay, which was thoroughly consolidated by rolling with corrugated rollers after being spread in thin layers. The inner slope is two to one, the outer one and one-half to one, and carefully turfed. The inner slope is paved with bricks laid on edge with hydraulic cement. On the top of the banks there is a gravelled roadway, twenty feet wide, margined on the water side by a granite coping and iron fence. The bottom of the reservoir is concrete, six inches thick, which is from three to four feet lower than the flow line to the city, and has a gradual fall towards the centre of the northern bank, where two cast-iron waste mains pass through the bank.

In the division bank there are constructed two chambers or wells. The influent chamber, near the south bank, is built of brick and stone, and the gates so arranged that the water can be pumped into one or both compartments at the bottom, or allowed to rise and flow into either basin down stone steps set to the angle of the slope. From this chamber two 30-inch cast-iron mains pass through the southern bank. The effluent chamber, near the northern bank, built of brick and stone, has three gates on each side (with screens), at different elevations opening into the two compartments. Two 30-inch mains pass from this chamber through the northern bank. The floors of the influent and effluent chambers are three and four feet above the bottom of the reservoir, thereby providing for a large settling space in each basin. On the outer slopes of both banks there are stone vaults, in which are placed the valves. The surface of the water is thirty-seven feet higher than that of the old reservoir, and forty-two feet above the highest point in the city. A 24-inch main, passing alongside the old reservoir, leads to the old pumps, and is connected by separate connections with the old reservoir, and the 24-inch main to the city, in order that it may be used either as a pump or supply main. From the north side of the new reservoir a 30-inch main, having a gradually descending grade, is laid to the city, and along this main are numerous valves and branches, providing for future extensions. The reservoir was completed and put in use January, 1876. Four years after its completion, the consumption had increased to 5,849,894 gallons, and the rate *per capita* per day was 92 gallons. More pumps were needed, the present pumps being in need of repairs, as the tax upon them, pumping through a long and tortuous main to the new reservoir, was very heavy. Surveys for a new pump site were made by Col. Cutshaw, city engineer. It was ascertained by him that, to supply the reservoir by gravitation, a conduit costing several million dollars, and from seventy to eighty miles long, would have to be built. So this idea was abandoned. He finally recommended a location for the new pump-works, on the James river and Kanawha canal, from which power would be gotten, two miles west of the old pumps, and two-thirds of a mile from the new reservoir.

In 1880 the council approved the plan, and under his direction the work was commenced and finished. At this point there were two locks near together, each having a lift of ten feet. A new channel was cut around the locks, which gave a head of twenty feet. A channel was also cut around a third lock about two miles farther west, and a head wall and gates put in. The canal channel was deepened and widened for a distance westwardly 6½ miles; and a feeder at this point, leading from the canal to the river, was also deepened and widened. The feeder entered the river about 1,000 feet above Bosher's dam, a substantial dam

already built and used by the canal. At the junction of the feeder and canal a granite head-wall with gates was erected. The area of the channel was enlarged to a capacity of 705 cubic feet per second. A substantial stone pump-house of Gothic design was erected, and a head-wall, with waste-gates, built at the lower end of the fore-bay. The flow of the canal is nearly three times the quantity required for the present pumps. After a careful examination of various competitive designs for pumps and water-wheels, a combination submitted by Prof. Chas. A. Smith, of St. Louis, was selected, and with some modifications and changes, the machinery was put up by H. A. Ramsay & Co., of Baltimore. The water-wheel is a vertical partial turbine, 23 feet 7½ inches in diameter, perimeter 20 inches wide, buckets concave and 23 inches deep. The wheel revolves vertically. Water is brought to the wheel by a flume 5 feet in diameter, and connected by a goose-neck bend with a large guide chamber and diffuser at the base of the wheel, so as to deliver the water at right angles to the buckets, and acts on about one-eighth of the circumference at once. The buckets and diffuser are so shaped as to lose the water as quickly as possible after its action upon the wheel. A shaft 18 feet long and 12 inches in diameter extends only on one side of the wheel. Upon the shaft are three crank arms, set at an angle of 120 degrees to each other, and of such length as to make a six-foot stroke of plunger; they are so proportioned that the moment one pump ceases to deliver, another commences, therefore the revolution is perfectly uniform. The pumps are single-acting, vertical plunger pumps, fourteen inches in diameter; each pump is supplied with three cornish valves, — suction, intermediate, and discharge. The pumps are connected by 20-inch diameter branches, with a 36-inch suction main, charged under a 20-foot head, and deliver into 30-inch main, passing under the fore-bay, and rising, by a gradually ascending grade, 161 feet to the new reservoir. There are three wheels and three pumps to each wheel, each set having a capacity of 4,000,000 gallons, or a total capacity of 12,000,000 gallons in twenty-four hours. At their maximum rate the wheels make 20 revolutions per minute, and require 285 cubic feet of water per second. The water necessary to run the pumps is discharged into the Richmond level of the canal, and is again used by several manufactories and mills in the city.

During the construction of the water-power pumps, and under a demand for immediate supply of water in the drought of 1881, a Worthington Duplex Compound Steam Pump, with a daily capacity of 6,000,000 gallons, was erected. This was the pump used at the Exhibition grounds, in Philadelphia, in 1876. It is now rarely used, but kept in good order, as a reserve in the event of accident or damage to the canal by high freshets in the river.

It will be seen from the foregoing description that the pumping machinery of Richmond is of various designs. At the upper station there are three vertical partial turbine wheels, with single-acting vertical pumps, and a Worthington Duplex Compound Steam Pump. At the lower station there are six old-fashioned, low-breast water-wheels, working six double-acting horizontal piston pumps, and a Jonval turbine wheel, working two horizontal double-acting piston pumps. The Guild & Garrison steam pump was sold. The pump mains are so arranged or connected that one or both plants can be used to supply the higher reservoir, or the lower reservoir can be filled from the new reservoir.

The city distribution is divided into two services; the high service is supplied from the new reservoir, the low service from the old reservoir. The daily consumption of the high service amounts to 7,500,000 gallons, the low service to 3,500,000 gallons. The maximum pumping capacity is 24,000,000 gallons per day. The total storage capacity is 49,000,000 gallons. There are 28,700 lineal feet of pump mains, 10,981 lineal feet of supply mains, 70.7 miles of distributing mains, and 9,850 taps or water connections. The present population is estimated at 90,000, and the daily consumption 11,311,013 gallons, and the rate *per capita* 126 gallons. It will be observed that the city has now a pumping capacity more than double the daily consumption, and if the waste was reduced and the daily consumption brought even to a liberal quantity, say 60 gallons *per capita*, the pumping capacity would be nearly five times the daily consumption.

I will say in closing that the water works in Richmond are one of the oldest in the United States. In presenting this description to the Convention I have endeavored to make it as brief as possible, and if there are any points which are not clear to any of you, upon which you would like further information, I would be very glad to answer any questions which may be asked me.

DISCUSSION.

Mr. CLARK. — I should like to ask what the quality of the water is.

Mr. BOLLING. — The water is perfectly healthy, but for two-thirds or three-quarters of the year it is unattractive in appearance. It is healthy at all seasons, for we have had it carefully analyzed by different chemists, but it has the appearance of being muddy, although it is not muddy. One or two of the tributaries of the James river flow through very red lands and very fine soil, and for miles and miles above is a rocky channel over which the water flows, and the water gets so colored that it never becomes perfectly clear. But after the sand and heavier sediment has been removed, which is provided for in this reservoir, we get water which is colored, but pure.

The PRESIDENT. — How often do you have to clean the reservoir?

Mr. BOLLING. — We have not cleaned our new reservoir since we built it, but we have carefully measured the rate of deposit, and it has averaged an inch a year since its construction, in 1874. I have stated that our power, as well as our supply, is brought down the old canal for a distance of six and a half miles, and we carry into execution there very much the same idea that Mr. Babcock recommended at Little Falls, N. Y. There is a large amount of water stored above Bosher's dam in the river, from which we take probably twenty-five per cent. of the average flow of the river. And, in order to secure the benefit of the purification of the water, three different sets of head-walls and gates were built around the canal, the old locks themselves forming dams, as it were, so as to allow the water to flow with tremendous velocity through the gates, equivalent to having a fall over a dam, and to be thoroughly turned over; and then in the more quiet current from that point to the pumps it is given an opportunity to settle. And there is no question of the value of this, for ever since I have had charge of the works I have had samples taken at various times from the river above Bosher's dam, at different points in the canal, at the pump-house fore-bay, in the reservoir,

and at the hydrant. The water in the fore-bay, in appearance, is better than that in the river, in analysis it is a great deal better, and after having had four days to settle in the reservoir, it is better than in the fore-bay.

Mr. Babcock. — May I ask, Mr. Bolling, if there is any difference in the temperature of the water at the time it passes the first dam and when it finally passes the last one?

Mr. Bolling. — Yes.

Mr. Babcock. — The difference in the temperature would indicate whether there was any oxidation going on?

Mr. Bolling. — There is a difference in the temperature.

Mr. Babcock. — That shows that the dam is producing a good effect in oxidizing the water, and is precipitating a certain amount of impurities which would create heat, and thereby raise the temperature of the water. I think that is the fairest test as to the purification of water by aeration. I discovered the same thing at Little Falls, that there was a very marked change in the temperature from the beginning of the canal to the end, and I am glad to know you have found the same result.

FRICTION IN COLLECTING METER RATES.

BY

Geo. F. Chace, Supt., Taunton, Mass.

Careless and wasteful consumption, and consequent deficient supply, is a common experience of water departments.

An obvious remedy, and one now often adopted, is the compulsory use of meters. When not compulsory, their use is generally encouraged in all practicable ways.

Papers have been read before this Association, calling attention to defects in these machines, — defects which result in loss to water companies from under-registration.

Another side to the question might be presented. When meters are kept in good working order, and are substantially accurate, consumers are sometimes astonished at the size of their rate bills, because they are asked to pay for all the water, which, according to the dial, has passed through the meter, whether that water was a legitimate or wasteful consumption, or had been passed off in leaks of which the proprietor was not aware.

Then is likely to ensue "Friction in Collecting Meter Rates."

How to stop waste and yet avoid trouble with the consumers; how to diminish friction between the consumer and collector, and yet to exact justice; how to keep peace and harmony between the citizens and water officials; to secure the confidence of the former in the efficiency of the latter, — are questions to which this paper seeks to find an answer.

Patrick Henry once said he knew of no way of judging of the future but by the past; which was only another way of saying that men should be guided in their actions by the results of experience.

Perhaps the experience of the water department of Taunton, in relation to

the subject of this paper, may not be without some general interest, and may afford the most useful means of giving hints for practical guidance.

Meter rates in Taunton are payable annually, January 1–20, except that very large consumers pay quarterly. Readings of all meters are taken once a month. For several years it has been customary each month to notify persons whose meter readings indicated an excessive consumption. For a year or two previous to January, 1888, these notices were sent by postal cards, bearing a printed form. At that time a case occurred of excessive consumption, owing to a bad leak.

A postal card was sent to the consumer, but he claimed that he had never received the notice, and requested an abatement of his bill, on the ground that, if he had been properly notified, he might have stopped the leak and saved himself a large expense.

Not wishing to take advantage of the misfortune of a citizen, the commissioners granted the consumer a liberal discount from the face of his bill, but directed the clerk thereafter to send his notices by autograph letters which should be copied in a special copying book.

From that time until January, 1889, it was the practice for the foreman to look over the meter-book, on its return by the inspector, and to report at the office such cases as he had observed of excessive consumption. Notices were then written by the office assistant, in the name of the clerk. (For the sake of clearness it may be well to state that the officer styled in many water departments "Registrar," in Taunton is called "Clerk," and since 1883 the clerk has also been superintendent.)

Notwithstanding these attempted precautions, several instances occurred in January last where the meter-bills were large from an unusual consumption, without a notice having been sent to the consumer.

Although the sending of notices was regarded by the commissioners merely as an act of courtesy which they were not bound to perform, yet the consumers felt aggrieved, on receiving a bill, the amount of which was an unpleasant surprise.

The method pursued by the writer, in adjusting such difficulties, may be best understood from one or two examples.

Mr. M. is the proprietor of a tenement-house of which the service is supplied through a meter. From this house a pipe runs underground to another in the rear, — both services being thus supplied through the same meter. In January, 1888, Mr. M.'s bill for this service was $12.18. In January, 1889, it was $39.73. The number of tenants had been smaller in 1888 than in 1887. Naturally this man was surprised and reluctant to pay an amount more than three times as large as he had expected. An examination of the letter-book disclosed the fact that no notice for excessive consumption had been sent. The underground pipe between the houses was very suggestive of a chance for a leak. A cheap class of tenants might have been careless and left faucets running in the winter to prevent freezing, or in the summer to cool the water. But whatever the cause, the surprise remained. The matter was compromised by throwing off the odd $9.73, — thus reducing the bill to $30, an amount still large in comparison with $12.18. Subsequent events proved that there had been no leak, but carelessness on the part of the tenants. In this case the meter was a $\frac{5}{8}$-Union Rotary, set August, 1885, and has never been out for repairs.

Mr. F.'s bill for January, 1889, was $24.50, while in January, 1888, it had been only $10 for the same service. This again was a great surprise, as during the summer of 1888 the family of F. had been in Europe, and the water was shut off. The correspondence between Mr. F. and the clerk of the water commissioners will best explain how this matter was adjusted: —

"TAUNTON, Dec. 28, 1888.

"*My Dear Mr. Chace:* — An employé of the water board was at my house yesterday to look at my water-meter, and said that there had been a sudden jump in the amount of water recorded this year, sending the bill up from the usual $10 to $25. A similar thing has occurred once before, in 1884, carrying the bill up to $18.50. Every other year since I have lived here, the consumption has come within the minimum charge, and in that year, 1884, I had used less water than usual, from the fact that it was a wet season, and I had not used the hose much in summer. This year it has not only been wet, so that I have used the hose hardly at all, but I was absent from the middle of July to the middle of September, and shut the water off outside of the meter. There has been a slight leakage in the water-closet upstairs this fall, and I have been waiting some time for the plumbers to come and fix it; but it is entirely inadequate to account for the excess of water recorded, in view of the fact that there has been so much less used this year than is usual.

"Doubtless the water board has full faith in the integrity of water-meters, but my confidence in them has become sadly shaken. I paid the excess in 1885, because I could not say certainly that the meter lied; but inasmuch as it went back at once to the old rates, and has remained there ever since, in spite of the fact that I have not been sparing of water, and has only undertaken to come its little game on me this year, when I have been absent a month longer than usual, and have had no need of water for the garden, I feel morally certain that it is not to be depended on for absolute moral integrity. Some leakage there has been, but I cannot think it could possibly add $15 to my usual consumption.

"Yours very truly,

"———."

To this letter the following answer was sent: —

"TAUNTON, Dec. 31, 1888.

"DEAR MR. ———: —

"I find it has been customary to read the meter at your residence about the tenth of each month. During July, August, and September no readings were made, as our agent was unable to gain entrance. From June 10 to October 10 there were run through the meter, according to our records, 3,526 cubic feet. This is the difference between the June and October readings.

"You say you shut the water off outside the meter from the middle of July to the middle of September. That would leave from June 10 to July 15, and from September 15 to October 10 to account for 3,526 cubic feet.

"The inspector reports to me a leaky water-closet. You admit this, but think the leakage entirely inadequate to account for the apparent large consumption.

"Not trusting to theories, this afternoon I measured the water flowing in a stream one-sixteenth inch in diameter, under the ordinary domestic pressure,

within a given time. The result was a gallon in twenty-eight minutes. At this rate we should have in sixty days, 3,085.8 gallons = 412.55 cubic feet. 3,526 ÷ 412.55 = 8.5 +. The flow of a stream, of course, varies with the square of the diameter of the orifice.

"$\frac{1}{5} \times \frac{1}{5} \div \frac{1}{10} \times \frac{1}{10} = 10.2 + \frac{1}{6} \times \frac{1}{6} \div \frac{1}{10} \times \frac{1}{10} = 7.1.+$

"Therefore, the leakage of a stream between one-fifth and one-sixth inches in diameter would account for your large consumption.

"Yet, although I am inclined to think the meter is not in error, I can safely assure you that the commissioners will not desire to be sharp with an honorable gentleman, whose consumption has been large, not on account of negligence on his part. When I state the facts to them next Saturday evening, I have no doubt that, under the circumstances, they will be ready to make some abatement. If you can inform me before that time that the leak has been stopped, that fact might influence their minds in determining the amount of abatement.

"Yours truly,

"GEO. F. CHACE."

This communication brought the following answer: —

"TAUNTON, Jan. 3, 1889.

"DEAR MR. CHACE: —

"Your courteous letter of the 31st December was received and studied. I have been trying to get the facts in the case 'down fine,' and find them to be, as nearly as I can make out, thus: —

"1. I am not aware of any leakage before the summer vacation.

"2. I find that we left the house July 19, at which time I shut the water off, as I supposed, at the entrance to the cellar, beyond the meter. But my wife, who came back to the house July 30, after eleven days, found there had been some leaking at the vent-hole of the cut-off, and sent for the plumber, who said the water was not shut entirely off. I had turned the screw until it stopped, and supposed it was quite tight, but it proved to have needed an extra wrench. That, however, could not have left much of an opening, and it was entirely stopped on the 30th of July, so that from that time there can have been no leakage within the house. The 3,526 cubic feet must then consist of the water used from June 10 to July 19, — the leakage from July 19 to July 30, — and the regular usage from Sept. 15 to Oct. 10.

"3. The leakage in the water-closet is recent, and the amount only a dribble.

"4. I found, one day, a dribbling from an outside sill-cock; that was early in the fall; I turned it off at once, and it has been shut ever since.

"5. Last Monday the plumber came and went over the whole business, and I think it is now as tight as a drum.

"I have given you thus, as carefully as I can, all possible sources of waste. It does not seem to me possible that there has been sufficient to add $15 to my usual $10, considering the fact of a long absence and the failure to use the hose as usual. It may be that it is my ignorance of the nature of the case that makes me think so, and if so, I am ready to pay my dues.

"I leave the matter to you and the Board with entire confidence.

"Yours very truly,

"_____."

As a result of this correspondence, the gentleman's bill was reduced from $24.50 to $15, thus dividing the chances of error between the consumer and the water department. This arrangement was entirely satisfactory, and the bill was settled without further controversy. It may be interesting to note that, in this case, the meter was ¾-inch Crown, set June, 1882, and had never been out for repairs.

In a few instances besides those mentioned at the January settlement, persons objected to paying their meter bills, on the ground that they were excessive, and that there must be a mistake on the part of the water officials, or something wrong with the meter.

But by showing them from the letter-book that they had been duly notified of excessive consumption, yet had neglected the notice, and by sending to examine their premises an inspector who discovered a good-sized leak, or detected, on the part of tenants, proceedings which wasted much water, by going over the record-book month by month, and showing them just where the large consumption occurred, one by one they came into line and cashed up, generally in perfect good humor, and never with anything more serious than a slight reluctance and a mild protest.

Desiring to avoid in the future all chance for debate as to the justice of bills, and to make sure that the work was thoroughly done, every month, beginning with February last, as soon as the meter readings have been returned by the inspector, the writer has personally examined every reading. Whenever the monthly consumption, as shown by the difference of readings of two successive months, exceeded the proportional part of the minimum rate of $10 per year, the register number, name, street number, and consumption in feet were copied upon a sheet of paper. When a list had thus been made of all such consumers, omitting quarterly meters, the record of 1888 was examined with reference to each one of those names upon the list, and the monthly average for each for last year written on a line with that of the month in question of the present year. When there was little difference in the figures, the name was erased from the list, but if the monthly consumption was considerably above the average, the names were retained and this revised list handed to the office assistant, who sent notices to each one, according to the following model: —

"FEB. 10, 1889.

"MR. JOHN SMITH:

"*Dear Sir*, — Our meter inspector reports that the registration of your meter at 3040 Commonwealth avenue shows an excessive consumption for the month of January, 1889, namely, 15,000 gallons. We do not object to this, if it is known and understood by you, but if it exists without your knowledge and consent, we would suggest that an investigation now may perhaps save annoyance and a large bill at the end of the year.

"Yours respectfully,

"GEO. F. CHACE,

"*Clerk.*

"Per C."

Up to May 25, 1889, the Taunton Water Department had in service 892 meters. The number of notices sent thus far in 1889 has been as follows: January, 78; February, 7; March, 26; April, 18; May, 40.

What has been the result? Some, doubtless aware that they were using considerable water, have said nothing. Many have expressed their thanks for the courtesy, and said they had discovered leaks which accounted for the over-consumption, and were glad to know the fact and have the leaks repaired. Others, of course, thought there must be "something wrong with the meter." When such a course was deemed necessary to satisfy the consumer, the meters have been tested. This Association does not need to be told that, in almost every case, the test showed the registration of the meter to be in favor of the consumer. Men of the department have been sent, without expense to the consumer, to see if leaks could be detected. Often they have been found, and the plumbers given a job of repairing.

When no leaks have been discovered, and the meter has been tested without satisfying the citizen, the hint has been thrown out that tenants might be careless in letting the water run, but would be slow to acknowledge the fact to a landlord who might thus be led to raise the rent.

Yet they might be more careful when they found they were under suspicion. A diminished consumption for the following month often proved the usefulness of such a hint.

During the past five months the discovery has been made that in reading nearly nine hundred meters every month, the inspector has in that period made five or six mistakes. Considering the darkness of cellars and the amount of the figures, such mistakes are perhaps somewhat excusable, especially as such errors are sure to betray themselves in subsequent readings.

With meters read every month, stoppages can be reported, defects repaired, and water-takers notified of a consumption excessive from whatever cause. Thus both the department and the consumer are protected from unnecessary loss.

The writer is engaged in preparing a record-book which shall contain a full account of all the meters ever used in the Taunton water works, the date and place of setting and of removals, with memoranda of causes of removal, and the readings when set and removed. It will thus contain a biography of each meter.

Another book is in preparation, to contain a record of all meter tests, and a tank and scales have been set up in the work-shop for the purpose of testing all new meters before setting, and others when out for repairs.

Seventeen different kinds of meters have been employed in the history of the works, and ten different sorts are at present in use.

By such means the department may be expected to have a good degree of knowledge of the value of machines of the various makers, and of the character of individual meters of the same maker.

Is it unreasonable to hope that the methods indicated in this paper will secure the confidence of consumers and diminish "friction in the collection of meter rates"?

At least this may be said: if care in keeping the records, faithfulness in repairs, patience and forbearance with the irritating criticisms of persons having less technical knowledge than the water official, frankness in admitting a mistake when one has been made, and polite firmness in adhering to the truth when the

official knows he is in the right, — if all these do not secure the confidence and support of a community, nothing else will.

If any suggestions have been made which may prove of practical value to members of this Association in the performance of their official duties, the object of the writer will have been accomplished.

RECENT PROGRESS IN BIOLOGICAL WATER-ANALYSIS.

BY

WILLIAM T. SEDGWICK,
Associate Professor of Biology,
Massachusetts Institute of Technology, Boston.

A biological analysis of water, strictly speaking, is an impossibility. Water may be analyzed chemically and resolved into its components, hydrogen and oxygen, but a biological analysis of water is an impossibility, because water is absolutely lifeless and inorganic. By a chemical "water-analysis," however, the chemist does not usually mean the analysis of a portion of pure water, but only a chemical examination of the substances dissolved in, or carried by, the water. In precisely the same way a biological "water-analysis" is understood to be simply *an examination of the organisms present in a particular portion of water.*

The biological analysis of a water must deal with all the organisms which can be detected therein; but inasmuch as the coarser water-dwellers, — the fishes, the frogs, the snails, the water-weeds, etc., — are seldom collected in a sample for water-analysis, there are usually present only the very small, and often quite invisible, organisms which may nevertheless be exceedingly numerous. Practically, therefore, the biological examination is directed to the inconspicuous forms of life, which often swarm in waters, even in those used for drinking. Taken as a whole, these organisms are known as the "microörganisms," and form a vast group of living things, some of them nearly, and some of them quite, beyond the vision of the naked eye. In dealing with the microörganisms in a sample of water, or in a water-supply, the coarser organisms must by no means be neglected; but the biological analysis of water as at present conducted is concerned especially with the microörganisms; and in the present paper no great departure will be made from the prevailing point of view.

Microörganisms are of two different kinds, and must be studied in two very different ways. Although all might perhaps be described as "microscopic" in size, those in one group are so much smaller than those in the other as to be almost smaller than "microscopic." These smallest microörganisms are the bacteria; and, although they may be seen by the help of the microscope, and, indeed, can be seen individually in no other way, they cannot be satisfactorily studied — still less counted — by the microscope alone. These microörganisms — the bacterial — are therefore detected and chiefly studied by the method of "cultures," otherwise known as "Koch's method," which I had the honor to describe and demonstrate at a meeting of this Association a little more than a

year ago. Of the bacterial microörganisms I shall speak to-day only incidentally, although within the year our knowledge of them and of their doings has been steadily advancing.

On this occasion I desire rather to turn your attention to the second division of the microörganisms, the microscopical. This includes all microörganisms except the bacterial, and is separated from that group by the fact that while the latter require for their satisfactory study the employment of "cultures," the microscopical microörganisms may be detected, counted, and pretty fully studied by the microscope alone.

In a summary fashion the relations of these groups may be shown as follows: —

MICROÖRGANISMS.	
Organisms, either plants or animals, too small to be studied with the naked eye.	MICROSCOPICAL. Not requiring special "cultures." Easily studied with the microscope. Microscopic in size, or barely visible to the naked eye. Plants or animals.
	BACTERIAL. Requiring special cultures for their satisfactory study. Difficult of study with the microscope, because almost sub-microscopic in size. Plants.

The bacterial microörganisms include the bacteria, as well as some yeasts and moulds. The microscopical microörganisms include a great variety of animals, such as minute entomostraca, like Cyclops and the water flea; various worms and wheel-animalcules; sponges and the fresh-water Hydra; infusoria, rhizopods, and such like; and among the plants, the diatoms, algæ, fungi (excepting those already mentioned), and the so-called "blue-green algæ." Beside the bacteria, these forms are mostly of giant size, and hence may be seen and studied with comparative ease by the aid of the microscope.

I am the more anxious to urge upon your attention the microscopical microörganisms, since it is with them that some of the more recent progress has been made in the biological analysis of water. Furthermore, it is in this field, in all probability, that some of the most interesting developments of the next year or two will be found. These are the organisms that often pave the way for bacteria in water, and possibly therefore, for the germs of disease. These are the organisms which are, in large measure, the source in water of the "organic nitrogen" (or albuminoid ammonia) of the chemists; the organisms, responsible in large measure, for odors, tastes, and turbidities in waters, either directly by their own activity, or indirectly by amassing organic matter, and eventually surrendering it as putrescible food for the more destructive bacterial microörganisms.

As long ago as 1850, Dr. Arthur Hill Hassall made a microscopical examination of the water-supply of London, perhaps the first ever scientifically made anywhere, and, in discussing his results, wrote afterwards, as follows:[1] "The deleterious properties of impure water depend, for the most part, on their *organic impurities*.

"Until very recently chemists did not, in general, attach sufficient importance

[1] Food and its Adulterations, p. 55, London, 1855.

to these organic contaminations, and in most of their analyses we find the different kinds of organic matter, vegetable and animal, living and dead, all lumped together. . . . Indeed, chemistry is but ill-adapted to investigate the nature of these organic matters; it gives but a very rough estimate only of their gross amount, and does not discriminate, as we have said, the animal from the vegetable, the dead from the living," etc.

For twenty years after Dr. Hassall's day, his work remained almost alone. In 1870, however, Professor Cohn, the biologist, of Breslau, in an extremely suggestive paper on the "Microscopical Analysis of Well Waters," perceiving, perhaps, better than any one else has yet done, the profound significance of such studies, wrote as follows:[1] "There is no doubt that microscopical examinations of drinking-waters, properly conducted, will strengthen and perfect the chemical examinations at the most essential points, and that they only will give us information upon certain questions which the reagents of the chemist cannot answer."

As if to justify his assertion, Cohn immediately proceeds to compare the results of chemical analyses with his own observations of corresponding microscopical conditions, and, as might have been expected, with interesting results. There is even here, however, no prolonged comparison of chemical with biological results, and hence no such fertile outcome as might have been attained.

After Cohn's paper we find nothing so suggestive up to the present day. It stands alone, so far as I know, in a serious and enlightened endeavor to coördinate and render mutually helpful, chemical and biological data. With this one brilliant exception, little progress has been made in the interpretation of chemical and microscopical analyses of water (though of the former vast numbers have been accumulated), simply, I believe, because chemists, on the one hand, have been content to name the most complex and the most important substances in their analyses "organic matter," therewith resting satisfied; while biologists, on the other, instead of seeking a simple explanation for the presence or absence of organisms, or endeavoring to learn their chemical significance, have too often dissipated their energies in struggles to classify those organisms which they could name, and to name those which they could not classify. Doubtless, also, the rise of bacteriology, soon after the appearance of Cohn's paper, with the intense interest which it aroused, did much to distract attention from the microscopical microörganisms, and to fix it upon the bacterial. But even concerning the bacterial microörganisms interest has been thus far principally medical. The discovery that infectious diseases may be propagated in drinking-water, caused general alarm. Most bacteria, however, are not disease germs; and yet they are scarcely less interesting on that account, for by their presence they always signify something, and in their absence are hardly less conspicuous. Bacteria are fungi; that is, they are not green with chlorophyll, and, consequently, since they cannot build up food for themselves from mineral matters, as they might do if they had chlorophyll, they are obliged to live upon ready-made foods. If, then, a drinking-water contains bacteria, living and thriving, there is no escape from the conclusion that there is or has lately been ready-made food in that water. Well waters usually contain few bacteria; and this we would expect from their poverty in ready-made food, — which is only

[1] Beiträge zur Biologie, I., 109.

another name for some kinds of organic matter. River waters usually contain numerous bacteria, and ready-made food is generally there in the shape of organic matter of one kind or another.

Now it is precisely this ready-made food that the bacteria must live upon, and which they oxidize eventually to mineral matters, that the larger, microscopical microörganisms abundantly produce, as may readily be understood by reference to the diagram at the end of this paper. (Compare the diagram and the explanatory remarks appended.)

It is plain that, if the microscopical microörganisms often furnish the chief support of bacteria, they are worthy of the closest consideration. But until lately, however desirable their enumeration and study might have been, investigation of them was comparatively difficult. No good methods for their quantitative study have been known, and this, quite as much as the all-absorbing interest in bacteriology, has prevented their widespread study. Up to the present time the best methods have made no pretensions to be quantitative, and microscopical examinations of water have been usually directed to the sediment obtained by letting a given sample stand for a longer or shorter time. The suspended matters have thus been more or less completely disregarded. Macdonald in England and Tiemann and Gärtner in Germany have no other methods to propose.

By straining through cloth a known amount of water, and afterwards detaching the organisms held back by the cloth, upon a slide, where they could be approximately enumerated, the biologists working for the Massachusetts State Board of Health made a decided step in advance. Mr. A. L. Kean, working under my direction, sought to improve upon the cloth method by the use of a sand-filter, and counted by means of the examination of a thousandth part of the whole in a ruled cell holding one cubic millimeter. Still more recently I have myself constructed a counting chamber, so arranged that a cubic centimetre, or more, of water may be examined directly, or, in case the organisms are few, the entire mass of sand and organisms left by filtration of a known amount of water (usually 100cc.) can be evenly distributed on a glass plate, then viewed with a moderately high power, and the organisms studied and enumerated with considerable precision. A full account of the various methods, with results obtained by their use, will appear in a forthcoming report of the State Board of Health of Massachusetts. At present I will only state that this one consists, first, in the *concentration* (if necessary) of the organisms in a large amount of water into a small amount, so that they may be readily scrutinized. This is done by filtration through a short column of fine sand in a narrow-stemmed funnel, the sand being supported upon a platform of the finest wire-gauge cloth. To secure the second point (the *enumeration*), the sand and organisms are washed down by distilled water into a shallow chamber, ruled into squares, each one square millimeter in area. These are passed successively through the field of the microscope, and their contents observed or counted. I may quote a few results: —

	Per cubic centimetre.
Boston. (Cochituate. June 11)	12
Waltham. (Filter-basin. May 13)	4
Waltham. (Reservoir. May 13)	9

	Per cubic centimetre.
Waltham. (Tap. May 13)	12
Lawrence. (Tap)	23
Newton. (Filter basin)	12
Newton. (Reservoir)	1,602
Newton. (Tap)	23 to 5,565

From these figures it appears that a teaspoonful of drinking-water often contains from twelve to fifty microscopical microörganisms, and may sometimes contain thousands. Indeed, they often far outnumber the bacteria, as, for instance, in the Newton reservoir, where, with 1,602 microscopical, only 6 bacterial microörganisms were found in a cubic centimetre of water. In this connection I may mention a curious result, which was disclosed by an application of the method to the Newton water-supply. Water was drawn from the tap in the railway station at Newton Highlands every morning, excepting on Sunday. On Mondays the numbers were observed to be very high, reaching into the thousands per cubic centimetre, while during the rest of the week they barely reached hundreds. Inquiry disclosed the fact that on week days water is pumped from the filter-basin directly into the service-pipes. On Sundays the pumps are not run, and the pipes are filled from the reservoir. The reservoir water, however, is much less pure than that drawn directly from the filter-basin; and this fact became immediately and strikingly apparent by the examination of a sample collected early on Monday morning, before the pipes had been filled from the filter-basin.

It may fairly be claimed, I think, that we now possess a simple, convenient, and effective method for the enumeration and study of the microscopical microörganisms. There is no doubt that this is a step forward in the biological analysis of water, which must henceforward include microscopical as well as bacterial examinations.

As the result of his own studies upon drinking-waters, Cohn, in the paper already referred to, laid down certain generalizations that do not seem to have attracted the attention which, if true, they should have received. For example (*l. c.*, p. 113): "We may divide the organisms in drinking-water [wells] into three categories, which correspond to different degrees of purity of the water:—

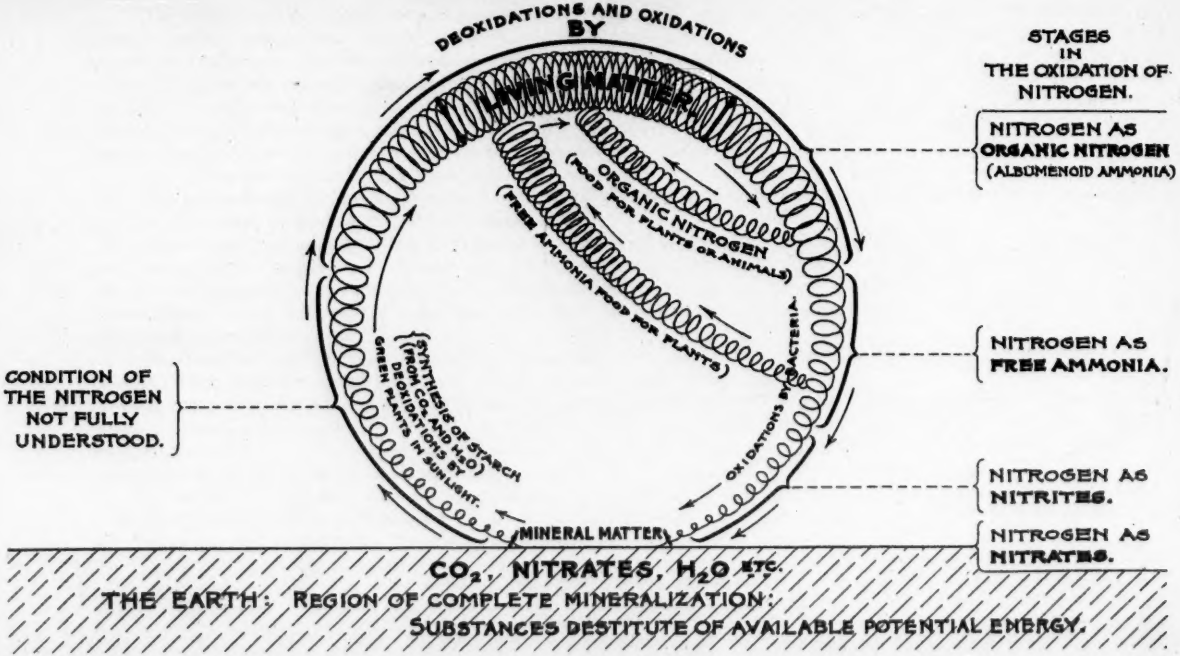
"1. Diatoms and green algæ indicate a water to which light has had access, and one poor in organic matter.

"2. Certain of the larger infusoria, especially the ciliated forms, feed on these algæ; while upon both the infusoria and the algæ, feed—

"3. Entomostracans, like Cyclops and the water-flea, worms, such as Naids and rotifers, and insect larvæ."

The presence of these last scavengers-in-chief Cohn does not regard as inconsistent with the purity of the water. He considers it to be the function of the rhizopods, carnivorous infusoria, rotifer vulgaris, mites, and the water-bears, to devour solid or undissolved bits of organic matter; and of the mouthless infusoria and the bacteria, to flourish upon dissolved organic matters. The latest

ORGANIC MATTER
IN SOME OF ITS
BIOLOGICAL AND CHEMICAL
RELATIONS.


DEOXIDATIONS AND OXIDATIONS BY
LIVING MATTER
STAGES IN THE OXIDATION OF NITROGEN.
NITROGEN AS ORGANIC NITROGEN (ALBUMENOID AMMONIA)
ORGANIC NITROGEN (FOOD FOR PLANTS OR ANIMALS)
FREE AMMONIA FOOD FOR PLANTS)
NITROGEN AS FREE AMMONIA.
CONDITION OF THE NITROGEN NOT FULLY UNDERSTOOD.
SYNTHESIS OF STARCH (FROM CO_2 AND H_2O) DEOXIDATIONS BY GREEN PLANTS IN SUNLIGHT.
OXIDATIONS BY BACTERIA.
NITROGEN AS NITRITES.
MINERAL MATTER
NITROGEN AS NITRATES.
CO_2, NITRATES, H_2O ETC.
THE EARTH: REGION OF COMPLETE MINERALIZATION:
SUBSTANCES DESTITUTE OF AVAILABLE POTENTIAL ENERGY.

EXPLANATION OF THE DIAGRAM.

The diagram on the opposite page is an attempt to show, in the simplest manner, and with special reference to water-analyses, some of the principal facts in the origin and fate of organic matter. In the long run, the history of organic matter is cyclical, and accordingly it has been marked out here upon a circle, springing from the earth and eventually returning to it. By stages of ever-increasing complexity, roughly indicated by the constantly closer and broader turns of the spirals, there are gradually built up from the inorganic matters of the earth and air, organic matters of constantly greater instability and larger potential energy, until, at the very top of the circle, living matter, the most "organic" of all matter, stands diametrically opposed to mineral or inorganic matter. This entire constructive phase (*anabolism*) is essentially a process of deoxidation, and is the special function of green (chlorophyll bearing) plants endowed with the energy of sunlight. At some stages, however, and especially near the top, there is reason to believe that the animals and the colorless plants also freely effect deoxidations and the construction of the higher forms of organic matter.

After death the organic matters of the recently living plant or animal are returned, step by step, to the earthy condition (the various acts of decomposition, taken as a whole, being sometimes described as *katabolism*) by processes of oxidation effected chiefly by the bacteria, which are therefore oxidizing agents *par excellence*. These organisms find their power and therefore their reward, in the energy which they derive from the oxidation of relatively unstable compounds to those more stable, and poorer in potential energy.

The brackets in the diagram approach too closely one to another. There are possibly important stages between, for example, "free ammonia" and "nitrites," which chemists have not yet fully apprehended.

It is probably very seldom that any particular portion of matter proceeds over the exact route indicated by the diagram. There are innumerable "short cuts" or "reverses," by which lately dead organic matter is rebuilt directly into living matter; or by which free ammonia or nitrites are fed upon by living plants. Such short circuiting is the rule, for example, in the feeding of the carnivora which devour animals lately killed, and composed largely of organic nitrogen. The upper of the included spirals in the diagram is meant to show such a "short circuit." Another, and highly instructive case is that referred to by Prof. Drown (p. 57), in which the living oscillaria in Jamaica Pond completely removed the free ammonia present. This is represented by the lower (and longer) of the included spirals. (See also p. 56.)

With this diagram in hand, it is hoped that the interpretation of the results of modern water-analyses will be greatly facilitated, even for those previously unfamiliar with the technical terms.

German work upon this subject (*Untersuchung des Wassers*, Tiemann und Gärtner, 1889) does scarcely more in this direction than quote the above remarks of Cohn, and adds, "At the present time more stress is to be laid upon the quantity than upon the quality of the microscopic organisms."

In my opinion, it is in working out precisely such inter-relations and interdependencies of the microörganisms as are suggested by Cohn that we are now making real progress, and are likely to advance in the near future. It is self-evident that such laws, if firmly established, must become of the greatest scientific and practical value to all concerned in the use and the supply of wholesome drinking water.

It is necessary, however, to go one step further. The protest of Dr. Hassal, quoted above, against the use by chemists and others of the indefinite term "organic matter," has lost none of its force by the lapse of time. On the contrary, it is less defensible than ever, and the time is gone by for students of water supplies to be satisfied if, in reports of chemical analyses, they find "the different kinds of organic matter, vegetable and animal, living and dead, all lumped together." Recent investigations show that such terms as "nitrates," "nitrites," and "free ammonia," have a definite meaning in important biological conditions, and some of these are suggested by the diagram at the end of this paper.

Finally, it is not too much to affirm that, if it ever existed, the time is gone by when either a microscopical examination alone, or a bacterial examination alone, will suffice to base a professional or expert opinion of water upon. And furthermore, it is becoming clearer every day that an opinion of a water based upon chemical observation alone (and, above all, upon a single analysis), is no longer a complete scientific opinion. A water-analysis henceforwards must be a threefold analysis, viz., chemical, bacterial, and microscopical; and even then the conditions of its origin and of the neighborhood of its source must be included as a factor of equal importance. The standard of water-analysis has of late unquestionably risen, and reports of "water-analyses," if they are to fulfil the conditions imposed by the most recent progress, must include three different examinations, as follows: —

EXAMINATIONS REQUIRED FOR A COMPLETE WATER-ANALYSIS.

I. Environmental, *i.e.*, a more or less complete study of the source of the water, together with observations of the surroundings, and investigation of specimens unquestionably normal, from the vicinity.

II. Chemical, *i.e.*, the usual chemical analysis, with special attention, however, to the state of the nitrogen present.

III. Biological, *i.e.* (1), *Microscopical*, viz., a determination of the number, the species, and, as far as possible, the conditions of the larger microörganisms present; as well as of the masses of *débris*, etc.

(2) *Bacterial*, viz., a determination of the number, and, as far as possible, of the species of the living bacterial organisms present.

DISCUSSION.

Remarks of Professor Drown.

The President called upon Prof. Thomas M. Drown to open the discussion.

Prof. Drown. — I may, perhaps, supplement Professor Sedgwick's paper by an account of some experiments I have recently made to determine what kinds of nitrogenous food algæ are capable of assimilating, and I have selected for this purpose the four substances which Professor Sedgwick has placed on his chart, namely, organic nitrogen, or albuminoid ammonia, free ammonia, and the nitrites and nitrates. From a sanitary standpoint it is the changes of the nitrogenous substances in water which chiefly interest us; and those changes are progressive in the direction already given, that is, from organic nitrogen through ammonia and nitrites to the complete mineralization of the nitrogen in nitrates. Now, leaving out of consideration the causation of disease by specific germs, we may say that we associate unwholesomeness with the idea of decomposition. Decay going on in water, in large amount, generally gives rise to offensive odor and tastes, which would cause one to reject the water without any professional opinion as to its wholesomeness. And there is positive evidence to enable us to say that nitrogenous substances, undergoing decomposition taken into the system are capable of causing sickness.

The presence of algæ in drinking-water is generally considered unneccessary, very often they are unsightly, and the cause frequently of unpleasant odor and tastes. And yet there is a good word to be said for the algæ, or, at least, for some of them. My experiments go to show that the algæ may be nourished by organic nitrogen, by ammonia, and by nitrites and nitrates. The first three mentioned are substances which are capable of undergoing further change. In some way the unwholesomeness of water is connected with this change, and I have been disposed to formulate this fact in this way: *The state of change is the state of danger.*

The last condition, that of nitrates, is incapable of further change or oxidation, but until we get to this stage there is change going on. Now, if the algæ will take up the organic nitrogen, the ammonia, and the nitrites, they will remove from the water substances capable of undergoing change, and in so far I cannot help thinking that they are doing a good work.

My experiments were made in this way: In each case I took two jars — battery jars are very convenient for the purpose — and put into both of them water containing, in solution, some one of the above-mentioned substances, and into one, only, some growing water-plant. The solution was analyzed at the beginning of the experiment, and the jars were then exposed to sunlight for several weeks, analyses of the water in the two jars being made at intervals of a few days. For organic nitrogen I used a solution of pepsin, a substance which decomposes very rapidly in solution, developing ammonia freely. In this case the jar without the alga showed very promptly a large amount of ammonia, and there was also a disagreeable odor after a short time. In the other jar containing the alga there was no odor, and free ammonia was not formed. It is impossible to say definitely in this case whether the plant fed directly on the pepsin or whether ammonia was formed and appropriated immediately, or that there was no accumulation of ammonia.

In another series of experiments an ammoniacal salt — ammonium chloride — was used. This was quickly absorbed by the plant, while the water in the companion experiment, with the same amount of ammonia, showed no change on standing. In still another series, sewage was added to the water in the jars, and in one — that containing the growing plant — the evidences of pollution disappeared in a short time, while the other retained all the characters of dilute sewage. In all cases the plant grew rapidly and seemed very healthy. The nitrites, in another series of similar experiments, were also removed from the solution by the growing plant. Now, I cannot help thinking that the algæ do a good work in taking up these products of decomposition, and thus preventing them from completing the changes which they would otherwise naturally undergo. The general impression as to the nature of the self-purification of rivers and surface-waters generally, is, I think, that the organic matter is ultimately completely oxidized, and that the green water-plants aid in this process by giving off oxygen as one of the products of their life. This process of oxidation certainly does go on, but it seems to me that with abundant plant-life in the water the probabilities are that the greater part of the introgenous matter will be absorbed before it is oxidized.

But it will be said, "Does not this vegetable growth ultimately die and give in its turn the same products of decomposition?" That is certainly the case with all living matter, but when a body of water is in a normal condition there ought to be enough new life arising out of the decomposition of the old to prevent the products of decomposition from accumulating. A "stagnant" pond is one in which decay gets ahead of growth. Here comes in, too, the interplay of animal and vegetable life in the water. The animal forms consume the vegetable life, and the products of the animal decomposition are absorbed by new plant life. In this latter case the service which the algæ do as in keeping the water wholesome is much greater than when they simply consume the products of the decomposition of other plants. Animal decomposition is what gives sewage its dangerous character. If the algæ are present in a sewage-polluted pond or stream in sufficient amount they may keep the water in good condition, or at least, prevent it from becoming foul. We have a confirmation of these experiments on the large scale in ponds which we know receive sewage. Horn pond in Woburn, as is well known, is a badly polluted pond, and the water is generally high in ammonia. But, occasionally, during the warm weather, when the plant life is abundant the ammonia is entirely absent.

During the past few months Jamaica pond, Boston, has contained an excessive amount of the alga *Oscillaria*. The water has been quite thick with it, and the pond had a reddish tint from this plant. Although the water was thus rendered unsightly and unpalatable, yet the ammonia, which is usually very high in this water in the winter and spring months, disappeared entirely in April and May. It is true that there are some algæ, — particularly those belonging to the blue-green variety, — which grow, under favorable conditions, with such great rapidity, forming lily-like masses, that they become a nuisance in themselves. When these masses are driven by the wind to one side of a pond, they may decompose on the shore-line and communicate to the water the characteristic "pig-pen" odor. Again, there is good reason to believe that many algæ have unpleasant odors and tastes while in a healthy living condition, and communicate their odors and tastes to the water. Still, we may affirm, as a broad statement, that the

ability which growing water-plants possess to absorb decomposing matters and the intermediate products of decomposition, renders their presence in surface waters generally advantageous. An ideal condition of affairs would be that in which we made use of the algæ to purify a water, and then filtered them out of the water before drinking it.

At the beginning of my remarks I mentioned the *nitrates* as food upon which water-plants might live. This was proved by experiments like those already described. But in this case we cannot look upon the algæ as purifying the water. Indeed, the contrary is the case. Nitrates represent the last condition of oxidation of nitrogen when it is entirely in the mineral form, with all trace of its organic origin lost. Now, when algæ live on nitrates they convert some of this completely oxidized nitrogen into organic nitrogen, which must go through the series of changes which we have described, until it again reaches the condition of nitrates; unless, indeed, some of the intermediate products are absorbed by new growth. You are all familiar with the rapid growth of organisms when a ground-water, high in nitrates, is exposed to light and air in an open reservoir. The water as it comes from the well is, as we will suppose, in perfect condition for domestic use, — free from all trace of organic matter; and in a few days we have it swarming with vegetable life, often associated with unpleasant tastes and odors. In such case the growth of algæ serves no useful purpose, but is the cause of a direct and decided deterioration of the water.

Remarks of Frederick P. Stearns.

The President then called upon Mr. Frederick P. Stearns, chief engineer of the Massachusetts State Board of Health, to continue the discussion.

Mr. Stearns. — When I was asked by the secretary if I would say something on this subject, I did not know what I could say that would interest you; so I arranged to exhibit to you a few samples of water, some of them containing algæ.

One of these two samples is a ground-water, just as taken from the ground, the other is the same water after storage in an open reservoir about a month. There is a slight difference in the appearance of these waters, but I do not think you can detect it from where you sit. I expected to find this sample from the open reservoir grass green, as it was about four days ago. The superintendent who sent this water wrote me that there had been a remarkable change in the appearance of the water, the green growth having settled to the bottom of the reservoir. The reservoir from which this water was taken was thoroughly cleaned about a month since, and filled with water direct from the wells; and the gates at the reservoir were then shut. In less than a week the water in the reservoir was filled with this green growth, which remained in it until a few days since, when most of it disappeared.

The third sample represents the Fall River water, drawn from a tap in this hall, which ranks high in appearance among the surface-waters of the State. You will observe, however, that it compares unfavorably with the ground-water in the first sample.

This sample represents what we term imperfectly filtered water. Water was originally supplied to these works directly, by gravity, from a storage reservoir; but, the water being unsatisfactory, a trench was dug when the reservoir was low, near the high-water line. In the bottom of the trench a culvert, with open

joints, was placed, and the trench was refilled. When the reservoir is full the water stands directly over some portions of the culvert, or filter-gallery, as it may be called, and filters continuously through a comparatively thin layer of earth. The result of this filtration is, that not much of the organic matter is removed, and an organism called crenothrix develops in great abundance in the water. It is a peculiarity of this organism that it becomes incrusted with iron. The flocculent, rust-colored sediment in the bottom of this bottle is crenothrix, with this incrustation. During two or three months in summer this water, when used for washing, leaves iron stains on the clothes. I have here another sample, blown from the dead end at a hydrant on the same works, which contains a large accumulation of crenothrix and iron. There are four supplies in the State where the water is very imperfectly filtered, and in each case there is a growth of crenothrix.

With these facts as a basis, the prediction may be made with a fair degree of certainty, that if you attempt to filter water continuously through a thin layer of earth, and without any means of cleaning the filter, you will be troubled with a a growth of crenothrix.

These two bottles contain growths of algæ, which develop mostly in the hot weather of summer. Although one of the waters is light colored, and the other much darker, the growths in them affect the waters in about the same way, as I will explain by these diagrams on the walls, which show the amount of albuminoid ammonia found by monthly chemical examinations of the water from June, 1887, to June, 1889.

The albuminoid ammonia of these particular waters represents approximately the variation in the quantity of algæ in the water. In these two diagrams you will observe that the line runs high in summer, in 1887 and 1888, reaching the highest point in August of each year, when it is about three times as high as during the winter. The upward tendency of the lines at the present time indicates that there may be another high point next August. There is one other water in the State which acts in almost precisely the same way as the two represented by these diagrams.

I will now call your attention to this sample of Jamaica pond water, which has been already spoken of. I presume you can see that it is very different in appearance from the other waters. This other bottle, containing a chocolate-colored mixture, was ladled up near the shore of Jamaica pond, and contains an accumulation of the particular organism found in great abundance in the water of this pond. I will now refer you to the third diagram, which represents the albuminoid ammonia found in the water from this pond. At the present time you will observe that it is extremely high, and that the rise began at the beginning of last autumn, and continued through the winter. The previous winter no marked rise occurred. The conditions during the winter before are not known, as the State Board of Health did not begin to examine water supplies until the following June. The marked drop in the line from June to July is a strong indication that the line was much higher before June.

These diagrams may prove instructive in two ways. First, they show that the waters of storage reservoirs and ponds in the State can be divided to some extent into classes which undergo similar changes during the year, and this classification furnishes a starting-point for determining the cause of these changes, and why they occur in certain waters and not in others. Second, they show how little

will be known of the character of a water in some cases from a single analysis. If a new supply is to be taken from a pond, or from an existing artificial reservoir, it would be desirable to have analyses taken frequently for a year, to determine if any changes took place which corresponded with changes taking place in the waters which give the most trouble.

Remarks of Desmond FitzGerald.

The President then called upon Desmond FitzGerald, Resident Engineer and Superintendent of the Western Division of the Boston Water Works.

Mr. FitzGerald. — I had not arranged to say anything on this subject, although, of course, it is an extremely interesting one to us all. When I first looked at these diagrams, and heard Professor Sedgwick begin his remarks, I thought I knew something about this matter, but now, after having heard what has been said by these gentlemen who have addressed us, I have come to the conclusion that I know nothing about it. There are several practical questions that come up in this connection which may be said to go hand in hand with these examinations, chemical, biological, etc. One question I want to ask is, Whether it is possible by chemical analysis to determine the loss in the water, in this first step, if it may be called a step, that is, the deoxidation process, or, in other words, the building up from the mineral into the vegetable; whether the chemical analysis is sufficiently delicate to determine that there is an absolute loss in the change from the mineral to the vegetable?

Professor Sedgwick. — It is.

Mr. FitzGerald. — I understand it is so. Then comes the practical question, Whether that loss is one which will be beneficial to the water consumers or not? If the decomposition of the algæ is a very slow one, I am at a loss to understand why, when we filter comparatively pure water through a sponge, for instance, at the end of twenty-four hours there will be such a mass of decomposing matter as to be very offensive. That was partly answered by Professor Drown's remark to the effect that the offensive smell might come as well from the processes of growth as from decay, which was a new idea to me.

Mr. Stearns' remarks have shown some interesting progress. It will be remembered, perhaps, by members of the Association that when this matter first started I took a somewhat favorable view of the probable results which would be obtained, and I think those have now begun to show themselves in these comparisons and classifications. But, of course, the matter is still in its infancy, for it is a very big subject, and we cannot expect everything at once. It seems to me these gentlemen are all giving intelligent study to it, and will bring us excellent results in the future.

When our water-supply in the city of Boston was attacked a few years ago, we ran all the water from Farm pond down into the Chestnut-hill reservoir. It was full of albuminoid ammonia, and was very offensive, so offensive that a bath in Boston water was really objectionable. I kept the water stored there in Chestnut-hill reservoir about a foot above high-water mark for several months, and it took almost all that time for the water to purify itself. And the question which it occurred me to ask in connection with that was, Whether the old idea that oxygen from the air had anything to do with the purification had been given

up? That was partly answered by Professor Sedgwick's remark that the effect of the bacteria was chiefly one of oxidation. Of course, if the bacteria purified the water, the exposure to the air had nothing to do with the process, I suppose. As matter of fact, the water did purify itself perfectly under the ice, so that very early in the spring it was as good as any water we ever delivered to the city. But a short time before the ice broke up the water was so bad that the effect of simply opening the gate was noticed by almost everybody in the city. I opened the gate one night on purpose to make the experiment in the cause of science. [Laughter.]

Professor Sedgwick's remark, that there is almost always a day of reckoning, seems to me particularly applicable to the case of Newton. You remember that not so very long ago, my friend Mr. Noyes, of Newton, was taking a very high position in regard to the quality of his Newton water in comparison with our Boston water. But gradually the net is drawing around him, and when Professor Sedgwick gave his figures showing that there were only 12,000 of these living creatures per litre in the Boston water, and from one to five millions of them in the Newton water, my spirits rose. (Laughter.) I think while Newton may possibly sell some of her water to Boston, it may be, perhaps, because the people there are very fond of soup. (Laughter.) I dare say I have gained a point now on my friend from Newton, if I did lose one a year ago. I am sorry I haven't something of more value to add to this discussion. I may say we have been examining the Boston waters from different sources under the microscope, and it is a matter of a great deal of interest to me, and surprising to see the difference in the water at different times and from different reservoirs. We are preparing on the Boston works to do this a little more scientifically than we have been doing, and we are going to start, perhaps, something which is in the nature of a biological laboratory, where we can make systematic records in connection with the chemical examinations, in addition to what the State Board of Health is doing, and perhaps carry it out a little more in detail. Mr. Forbes has been making a good many examinations of Brookline water, and I have no doubt he can add to this discussion, especially to the microscopical part of it.

In regard to the removing of the algæ, what I am particularly interested in now is to ascertain whether it will be an actual benefit to the water to remove from it the algæ in their first forms of growth; and it has seemed to me, without going into it scientifically, that it would be a benefit to the water. I know if we pass a large quantity of water through a sponge, we get certainly a very nasty mess as a result, and it seems to me that is the thing we want to remove from the water. (Applause.)

GENERAL DISCUSSION.

Mr. Noyes. — I have been trying to think of a reason, other than the reason Professor Sedgwick assigned, for there being so great increase in the number of bacteria in the Newton water on Sunday. I can only account for it in one other way, and that is this: You know Newton is entirely a residential city, and the business men are at home on Sundays, and it must be because there is no water drunk there that day. [Laughter.] I would like to ask Mr. Stearns one question with reference to that class of waters of which he showed a sample which he said was drawn from a dead-end, and that is, whether its appearance

was not to some extent due to the iron in the pipe, and not entirely due to the death and decomposition of the growth that he mentioned?

Mr. STEARNS. — I think the iron does not come from the pipe.

Mr. NOYES. — But is entirely due to the growth you mentioned?

Mr. STEARNS. — It may not be entirely due to the iron in the water, but I think it is chiefly due to this iron and the growth which collects it.

Mr. NOYES. — That is, the presence of the iron fertilizes the growth, or causes it?

Mr. STEARNS. — It is associated with the growth, I do not know how. The water also contains a high percentage of free ammonia, and that may have something to do with it.

Mr. ALLIS. — I would like to ask Mr. Stearns if the iron is from the pipes or the water itself. Is the water itself carrying the iron out of the pond? Is there iron in the water?

Mr. STEARNS. — I go mainly by what I have read about it. I don't know much about it from my own investigations, but I understand that water in going through the ground, particularly if the water contains a good deal of organic matter, will dissolve iron out of the ground. There are some tanks in Lawrence, where the State board is testing the filtration of sewage, and experiments in filtering through a tank of garden soil gives a red effluent, containing iron about the color of this sample. When the water comes from the tank it is perfectly clear before it is exposed to the air, but after it is exposed to the air the iron oxidizes and turns the water red.

Mr. FITZGERALD. — I should like to ascertain from these gentlemen who have made a special study of this matter, if the very addition of this last process of that circle, the mineralization of the water, does not, in effect, make the starting-point for the new growth? There is something in the way in which waters act, practically, that suggests that to my mind. The water in the main may not be at all like that which you send in from the reservoir, and I have had occasion to examine the contents of some very large pipes, and I have been astounded to find the quantity of growth in them. I have seen in a very large pipe the sponge so thick between the tubercles that it was one mass of living matter. And, then, the analyses of the water from the pipes, the tap water, shows the same difference; it changes in the same ratio. Now, that growth, if I understand this process correctly, that growth is at the summit of this profile, that is, the living matter has got up to its highest state of nitrogen, organic nitrogen, and it must have had an excess of mineralization to have built itself up under these unfavorable conditions on the inside of the pipe. Before that begins to decay, which, of course, will make the water very offensive to the town or city, it must have had this food to have built itself up with. Then we have a decay again, and then it passes into this state of mineralization. Now, the question is, whether the water going from the reservoir into the pipes does not contain such an excess of mineralization as to start anew the very circle of growth? It seems to me that is a subject I should like to have some light upon.

Professor SEDGWICK. — I should say it is not exactly that, but rather, perhaps, this: of course this diagram is the reduction to the lowest terms of the whole story, and it also shows the longest direct route which organic matter can take. Professor Drown has told you how there may be cross-links, as it were; how free

ammonia, for instance, instead of nitrates, may become food for green plants; how *Spirogyra*, which is a fine green alga often seen in waters, may take the free ammonia at this point, and may not allow it to get down here at all, but may seize it and build it right up into living *Spirogyra* by a shorter cut than usual. And we have reason to believe that the same thing may happen from the nitrite stage also. These algæ only take nitrates when they cannot get anything better. They are going to feed on organic nitrogen if they can; they are going to feed on free ammonia when they cannot get that; and they are not going to take nitrates except in the hardest times. This diagram represents the organic matter, so to speak, going over the most direct routes; but there are many short cuts and reverses, so that it may be a very long time before any particular particle of matter gets over the entire route.

Now, as to the sponge. It is not always green, and it does not absolutely need the sunlight, but it does in this case need something which has been green and has had the sunlight, or else has fed upon such things. In other words, it depends in the long run upon vegetable food. Now, as it lives in conduits and such places, there are always coming in green organisms which have been in the sunlight in the reservoir, and which have, perhaps, recently died, or which may be still alive, and the sponge takes them, — now dead organic matter merely, or even if living, — and builds them right up into *Spongilla*, one of the highest forms of organic matter (though one of the lowest forms of life). But, so far as we know, the sponge is not able to take nitrates and build them up into anything. That is the exclusive province of the green plants in the sunlight. They alone stand between us and destruction. If the green plants were exterminated, and if eternal night came on, we, in common with all other animals, would perish, because in the long run we are dependent on plants and the sun. So with the sponge. It is utterly powerless unless there come to it organic matter prepared by green plants, or, as we have called it, ready-made food, which may be either its nearest neighbors on the diagram, *viz.*: living animals and plants, or by a somewhat longer "short cut," highly energized, though dead, organic matter.

Mr. FitzGerald. — That answers the question, and it seems to me it tends to confirm exactly what I think showed itself to my mind practically, by some experiments I have been making, and that is, that *it is desirable to remove the algæ from the water before sending it into the mains.*

Mr. Chace. — I should like to ask Professor Sedgwick one question. I understood him to speak of bacteria as fungi. There have been some books published in which they have been spoken of somewhat doubtfully as algæ. I would like to ask if it has been definitely settled they are algæ.

Professor Sedgwick. — To all intents and purposes they are fungi, but some of them are so near to some of the algæ that it is still a matter of doubt to some whether they should be called algæ or not. Practically, we may regard them as fungi without any question. The moment they become algæ and take on chlorophyll, they move from the right hand side of that diagram to the left. But as 999 out of 1,000 of them are undoubtedly destitute of green coloring matter, they are for the present at any rate, and always practically, to be regarded as fungi.

Mr. Glover. — I would like to ask Professor Sedgwick if there is anything which will remove these microbes from the water. If his statement with regard

to our water is correct, and there is any such thing, I want to get one before I go back home. (Laughter.)

Professor SEDGWICK. — There are such filters. One hundred feet of fine sand will do it, and probably do it effectually. And there are some porcelain filters which will do it for a time at least. The ordinary filters are simply strainers. But there are a few which certainly do, at least for a time. How long they will continue to do so is a question. The microscopical forms are easily taken out, and still larger forms are still more easily taken out, but I understood the question to refer to the microbes, which are the bacteria. The microscopical forms are comparatively very large, but the bacterial are very small, and will go through almost any hole.

OBITUARY.

W. C. BOYCE, — Civil Engineer, Worcester, Mass., died July 15, 1889, aged 37 years 5 days. Joined this Association June 17, 1887.

New England Water Works Association Membership Roll.

SEPTEMBER 1st, 1889.

NOTE.—The secretary requests to be advised of existing errors or changes of address from that which appears in the following list:

ACTIVE MEMBERS—RESIDENT AND NON-RESIDENT.

Alexander, George
Civil Engineer, Quincy, Mass.

Andrews, Frank A.
Assistant Superintendent, Nashua, N. H.

Allen, Charles A.
City Engineer, Worcester, Mass.

Allen, Charles F.
Treasurer, Hyde Park, Mass.

Allis, Solon M.
Superintendent, Box 964, Malden, Mass.

Ayres, Henry W.
Chief Engineer, Hartford, Conn.

Babcock, Stephen E.
Hydraulic Engineer, Little Falls, N. Y.

Bacot, R. C., Jr.
Superintendent Meter Dept., Hoboken, N. J.

Batchelder, George E.
Registrar, Worcester, Mass.

Bagnell, Richard W.
Superintendent, Plymouth, Mass.

Ball, Phinehas
Civil Engineer, Worcester, Mass.

Baldwin, Charles H.
Box 2410, Boston, Mass.

Barney, W. H.
Superintendent, Milford, Mass.

Barns, Everett
Superintendent, Westerly, R. I.

Bassett, Carrol Ph.
Civil Engineer, 784 Broad street, Newark, N. J.

Battles, James M.
Lowell, Mass.

Beals, Joseph E.
Clerk and Registrar, Middleboro, Mass.

Belcher, J. White
Water Commissioner, Randolph, Mass.

Bickford, Nathan B.
Superintendent Water Works, O. C. R. R., Boston, Mass.

Billings, Wm. R.
15 Harrison street, Taunton, Mass.

Birkinbine, Harry
Superintendent, Council Bluffs, Iowa.

Bishop, George H.
Civil Engineer, Middletown, Conn.

Bolling, Charles E.
Superintendent, Richmond, Va.

Brackett, Dexter
Superintendent Eastern Div., Boston W. W., 221 Federal street, Boston, Mass.

Brady, John G.
Commissioner, Worcester, Mass.

Brand, Junius A.
Superintendent, Norwich, Conn.

Brinsmade, Daniel S.
Civil Engineer, Birmingham, Conn.

Broatch, J. C.
Superintendent, Middletown, Conn.

Brown, Arthur W. F.
Registrar, Fitchburg, Mass.

Brown, Edward H.
Superintendent Nevada County N. G. R. R., Grass Valley, Cal.

Brown, J. Henry
3 Tremont street, Charlestown, Boston, Mass.

Brush, Charles B.
Engineer and Superintendent, Hackensack Water Co., 13 Newark street, Hoboken, N. J.

Burnham, Albert S.
Superintendent, Revere, Mass.

Caldwell, Joseph H.
Registrar, Mystic Division, Charlestown, Boston, Mass.

Carroll, F. B.
Superintendent, Eastport, Maine.

Cate, E. W.
Water Commissioner, Newton, Mass. Address 113 Devonshire street, Boston, Mass.

Chadbourne, E. J.
Superintendent, Holbrook, Mass.

Chandler, Charles E.
City Engineer, 161 Main street, Norwich, Conn.

Chandler, Charles F.

Professor of Chemistry, School of Mines, Columbia College, New York city.

Chaplin, W. S.

Professor of Engineering, Harvard University, Hammond street, Cambridge, Mass.

Chace, George F.

Superintendent, Taunton, Mass.

Chase, H. S.

Superintendent, Great Falls, N. H.

Chase, John C.

Superintendent, Wilmington, N. C.

Clark, Ezra

President and Superintendent, Hartford, Conn.

Clark, Jonas M.

Superintendent, Northampton, Mass.

Coburn, Walter

19 Congress street, Lowell, Mass.

Cochran, Robert L.

Superintendent, Water Works, Nahant, Mass.

Codd, William F.

Superintendent, Nantucket, Mass.

Coffin, Freeman C.

Asst. with M. M. Tidd, 10 Tremont street, Boston, Mass.

Conant, H. W.

Superintendent, Gardner, Mass.

Conant, Whitney

Secretary Water Co., Long Branch, N. J.

Coggeshall, R. C. P.

Superintendent, New Bedford, Mass.

Cook, Byron I.
Superintendent, Woonsocket, R. I.

Crehore, Dr. C. F.
Box 1252, Boston, Mass.

Crandall, F. H.
Superintendent, Burlington, Vt.

Croes, J. J. R.
Civil Engineer, 13 William street, New York city.

Cunningham, W. B.
Superintendent, Trinidad, Col.

Cushing, Lucas
Asst. Superintendent, 221 Federal street, Boston, Mass.

Darling, Edwin
Superintendent, Pawtucket, R. I.

Davidson, James
Superintendent, Box 246, Central City, Cal.

Davis, Charles S.
Water Commissioner, Plymouth, Mass.

Davis, F. A. W.
Vice-President Water Co., Indianapolis, Ind.

Dean, Seth
Civil Engineer, Glenwood, Iowa.

Decker, J. H.
Secretary, Treasurer, and Manager, Salina, Kansas.

Denman, A. N.
Secretary and Manager Water Works, Des Moines, Iowa.

Dennett, Nathaniel
Superintendent, Somerville, Mass.

Dewson, F. A.
Water Commissioner, Newton, Mass. Address Box 1534, Boston, Mass.

Diven, J. M.
Secretary and Treasurer Water Co., Elmira, N. Y.

Dixon, William
Superintendent, Mt. Pleasant, Mich.

Dotten, William T.
Superintendent, Winchester, Mass.

Drake, Albert B.
City Surveyor, New Bedford, Mass.

Drake, B. Frank
Water Commissioner, Lake Village, N. H.

Drown, Thomas M.
Professor of Chemistry, Mass. Inst. of Technology, Boston, Mass.

Ellis, George A.
Civil Engineer, Room 71 Equitable Building, Boston, Mass.

Eaton, Horace L.
City Engineer, Somerville, Mass.

Evans, George E.
City Engineer, Lowell, Mass.

Fales, H. M.
Superintendent, Tonawanda, New York.

Fanning, John T.
Chief Engineer, St. Anthony Falls Water Power Co., Minneapolis, Minn.

Fitts, G. B.
Superintendent and Water Registrar, Attleboro, Mass.

FitzGerald, Desmond
Superintendent Western Division Boston Water Works, Brookline, Mass.

Forbes, F. F.
Superintendent, Brookline, Mass.

Freeman, John R.
Hydraulic Engineer, 31 Milk street, Room 51, Boston, Mass.

French, Melvin C.
Kingston, Mass.

Fteley, Alphonse
Chief Engineer, Aqueduct Commission, 213 Stewart Building, New York city.

Fuller, Frank L.
Civil Engineer, 12 Pearl street, Room 36, Boston, Mass.

Gamwell, J. H.
Treasurer Water Co., Palmer, Mass.

Gardner, L. H.
Superintendent, New Orleans, La.

Gerhard, William Paul
Sanitary Engineer, 39 Union Square, New York city.

Gerry, L. L.
Civil Engineer, Dover, N. H.

Glover, Albert S.
Water Registrar, West Newton, Mass.

Goodwin, John A.
Superintendent, Waterville, Maine.

Gould, J. A., Jr.
Assistant Engineer, City Engineer's Office, City Hall, Boston, Mass.

Gow, Robert M.
Superintendent, Medford, Mass.

Gowing, E. H.
Reading, Mass.

Granniss, Sherman E.
Superintendent, New Haven, Conn.

Greetham, H. W.
Local Manager, Orlando, Fla.

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Salem, Mass.

Groce, William R.
Superintendent, Rockland, Mass.

Haggett, Albert A.
Lowell, Mass.

Hale, Benjamin P.
Water Registrar, Haverhill, Mass.

Hale, Richard A.
Hydraulic Engineer, Lawrence, Mass.

Hall, Frank E.
Superintendent, Quincy, Mass.

Hammatt, E. A. W.
Civil Engineer, 5 Pemberton Square, Boston, Mass.

Hammond, J. C., Jr.
Superintendent, Rockville, Conn.

Hancock, Joseph C.
Superintendent, Springfield, Mass.

Harbach, Wm. F.
Water Commissioner, Newton Centre, Mass.

Harrington, John L.
84 Chestnut street, Cambridge, Mass.

Harris, D. A.
Superintendent, New Britain, Conn.

Harris, John
Water Commissioner, Waltham, Mass.

Hastings, L. M.
City Engineer, Cambridge, Mass.

Hastings, V. C.
Superintendent, Concord, N. H.

Hathaway, James H.
Water Registrar, New Bedford, Mass.

Hawes, Louis E.
Civil Engineer, 75 State street, Boston, Mass.

Hawes, William M.
Water Commissioner, Fall River, Mass.

Hayes, Ansel G.
Asst. Superintendent, Box 323, Middleboro, Mass.

Heald, Simpson, C.
Civil Engineer, 31 Milk street, Boston, Mass.

Hering, Rudolph
Civil and Sanitary Engineer, 277 Pearl street, New York city.

Heermans, H. C.
Superintendent, Corning, N. Y.

Henderson, Wilson
Superintendent, Peterborough, Ontario, Canada.

Hicks, R. S.
Secretary, Stafford Springs, Conn.

Hitchcock, Hiland C.
Treasurer, Addison, Steuben Co., N. Y.

Holden, Horace G.
Superintendent, Nashua, N. H.

Holman, M. L.
Water Commissioner, 3744 Finney avenue, St. Louis, Mo.

How, J. C., Jr.
Superintendent, Bath, Me.

Howland, A. H.
Civil Engineer, Room 71, Equitable Building, Boston, Mass.

Hyde, Horatio N., Jr.
Superintendent, Newtonville, Mass.

Inman, A. W.
Care Wisconsin Construction Co., 5 Tremont street, Boston, Mass.

Jones, A. J.
New Brunswick, N. J.

Jones, R. A.
Superintendent, Spokane Falls, Washington Territory.

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Treasurer, Auburn, Me.

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Keating, E. H.
Engineer and Manager, City Engineer's Office, Halifax, Nova Scotia, Canada.

Kempton, David B.
Water Commissioner, New Bedford, Mass.

Kent, Willard
Civil Engineer, Woonsocket, R. I.

Kieran, Patrick
Superintendent, Fall River, Mass.

Kimball, George A.
Civil Engineer, 194 Washington street, Boston, Mass.

Knapp, Horace H.
Lowell, Mass.

Knapp, Louis H.
Superintendent and Engineer, 280 Linwood avenue, Buffalo, N. Y.

Laing, W. H.
Superintendent Water Co., Racine, Wis.

Lansing, Edward T. E.
Civil Engineer, Little Falls, N. Y.

Learned, Wilbur F.
Assistant Engineer, City Engineer's Office, City Hall, Boston, Mass.

Leeds, Albert R.
Professor of Chemistry, Stevens Institute, Hoboken, N. J.

Lewis, Weston
Treasurer Waterville Water Co. Address Gardiner, Me.

Locke, Augustus, W.
Civil Engineer, North Adams, Mass.

Lockwood, Joseph A.
Superintendent, Yonkers, N. Y.

Lovell, Thomas C.
Superintendent, Fitchburg, Mass.

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Superintendent, Clinton, Mass.

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Capt. Corps of Engineers, U. S. A., Office District Commission, Washington, D. C.

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Superintendent, South Framingham, Mass.

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Treasurer Water Co., Norwich, N. Y.

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Chief Engineer, Baltimore, Md.

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Superintendent, Knoxville, Tenn.

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Superintendent, St. Albans, Vt.

Maxcy, Josiah S.
Treasurer, Gardiner, Me.

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Superintendent, Calais, Me.

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Superintendent, Muscatine, Iowa.

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Superintendent, Birmingham, Conn.

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Superintendent, Cambridge, Mass.

Newton, Henry M.
Secretary, East Saginaw, Mich.

Noyes, Albert F.
City Engineer, West Newton, Mass.

Osborne, Weaver
Water Commissioner, Fall River, Mass.

Paine, C. W.
Civil Engineer, Room 45, Third Floor, City Hall, Cleveland, Ohio.

Parker, F. H.
Burlington, Vt.

Pease, A. G.
Superintendent, Spencer, Mass.

Perkins, John H.
Superintendent, Watertown, Mass.

Philbin, John F.
Water Registrar, Clinton, Mass.

Phipps, Edward H.
Superintendent West Haven Water Co., New Haven, Conn.

Pierce, Charles E.
Superintendent, East Providence, R. I.

Pitman, Winthrop M.
Proprietor Water Works, Lower Bartlett, N. H. Address, Pillsbury Shoe Co., 103 Bedford street, Boston.

Plunkett, John F.
Water Registrar, Marlborough, Mass.

Porter, Dwight
Asst. Professor Civil Engineering, Mass. Inst. of Technology, Boston, Mass.

Ries, George J.
Superintendent, East Weymouth, Mass.

Rice, L. Fred
Civil Engineer, 4 Pemberton Square, Boston, Mass.

Richards, Walter H.
Superintendent, New London, Conn.

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Secretary, New Britain, Conn.

Robertson, W. W.
Water Registrar, Fall River, Mass.

Rogers, Henry W.
Superintendent, Salem, Mass.

Rotch, William
Civil Engineer, 8 Exchange Place, Boston, Mass.

Roullier, G. A.
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Superintendent, Hingham, Mass.

Shedd, J. Herbert
Civil Engineer, Providence, R. I.

Sherman, William B.
Mechanical Engineer, Box 379, Providence, R. I.

Smith, Solon F.
Superintendent, Grafton, Mass.

Stacy, George A.
Superintendent, Marlborough, Mass.

Stearns, Arthur E.
Water Registrar, Manchester, N. H.

Stearns, Frederick P.
Chief Engineer, State Board of Health, 13 Beacon street, Boston, Mass.

Swain, George F.

Professor of Civil Engineering, Mass. Inst. of Technology, Boston, Mass.

Swan, Charles H.

Civil Engineer, 25 Wabon street, Boston, Mass.

Taylor, Lucian A.

Civil Engineer and Contractor, U. S. Hotel, Boston, Mass.

Tenney, Joseph G.

Superintendent, Leominster, Mass.

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Asst. Superintendent, Hingham, Mass.

Tidd, M. M.

Hydraulic Engineer, 10 Tremont street, Boston, Mass.

Tower, D. N.

Superintendent, Cohasset, Mass.

Troy, J. W.

Superintendent, Pierre, Dakota.

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Water Registrar, Lawrence, Mass.

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Superintendent, Henderson, Ky.

Wilcox, William C.
Waltham, Mass.

Wild, George E.
With A. H. Howland, C. E., 71 Equitable Building, Boston, Mass.

Wilder, Frederick W.
Treasurer Aqueduct Co., Woodstock, Vt.

Winship, Horace B.
Civil Engineer, Norwich, Conn.

Winslow, George E.
Superintendent Water Works, Waltham, Mass.

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The Engineering and Building Record, 277 Pearl street, New York city.

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Contractor, Flushing, New York.

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Hattersley, John

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Langford, John T.

Contracting Engineer, 70 Kilby street, Boston, Mass.

Locke, Nathaniel C.

Damper Regulators, Salem, Mass.

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145 Broadway, New York city.

Morton, A. M.

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Mudge, B. C.

Investment Securities, 55 Equitable Building, Boston, Mass.

National Meter Co.

252 Broadway, New York city.

National Tube Works Co.

Pipe and Fittings, McKeesport, Pa. Address P. W. French, Sec., 70 Federal street, Boston, Mass.

Newman, J. J. & Co.

Contractors, 19 Wilson street, Providence, R. I.

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Warren Filter, 220 Devonshire street, Boston, Mass.

Oliphant, William

Water Filters, 112 Liberty street, New York city.

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163 Albany street, Boston, Mass.

Portsmouth Wrench Co.

151 Congress street, Boston, Mass.

Roberts, C. E.

Hartford Steam Boiler Inspection and Insurance Co., 35 Pemberton square, Boston, Mass.

Robertson, R. A., Jr.

Agent Builders Iron Foundry, P. O. Box 218, Providence, R. I.

Root, W. J.

Hydraulic Engineer (H. R. Worthington Co.), 86 Liberty street, New York city.

Ross, George

Valves, Troy, N. Y.

Ryder, N. F.

Varnish, Middleboro, Mass.

Sampson, George H.

Powder, 231 State street, Boston, Mass.

Sumner & Goodwin

Pipe and Fittings, 21 Oliver street, Boston, Mass.

Talcott, C. W.

Contractor, Woonsocket, R. I.

Tarr, H. G. H.

Civil Engineer (H. R. Worthington Co.), 86 Liberty street, New York city.

Terry, Benjamin S. (A. W. Harris Oil Co.)

85 Hope street, Providence, R. I.

Turner, Clark & Rawson (Wisconsin Construction Co.)

1 Beacon street, Boston, Mass.

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Thompson Water Meter, 143 Nassau street, New York city.

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45 Purchase street, Boston, Mass.

Wolfendale, Wm.

Agent Plumbers' Supplies, 76 Second street, Fall River, Mass.

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Woodman, George & Co.

41 Pearl street, Boston, Mass.

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"Adamanta Covered Pipe." Gates and Hydrants, Granite, cor. First street, South Boston, Mass.

Worthington, H. R.

Steam Pumps, 86 Liberty street, New York city.

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